AD-A031 804 FRAUNHOFER-GESELLSCHAFT GARMISCH-PARTENKIRCHEN (WEST --ETC F/G 4/1
BOUNDARY LAYER AEROSOL TRANSPORT MEASUREMENTS IN A VALLEY SYSTE--ETC(U)
JUL 76 R REITER, R SLADKOVIC DA-ERO-75-G-042

UNCLASSIFIED NL

1 OF 2
AD
A031804

(12)

-AD__________ B.S.

BOUNDARY LAYER AEROSOL TRANSPORT MEASUREMENTS IN A VALLEY SYSTEM

Part III

FINAL TECHNICAL REPORT

by

Reinhold Reiter
and Rudolf Sladkovic

July 1976

EUROPEAN RESEARCH OFFICE
United States Army
London W. 1, England

Grant Number DA-ERO-75-G042

Institut für Atmosphärische Umweltforschung
der Fraunhofer-Gesellschaft

D-8100 Garmisch-Partenkirchen, Germany
Kreuzeckbahnstraße 19

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

R&D 2215

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) BOUNDARY LAYER AEROSOL TRANSPORT MEASUREMENTS IN A VALLEY SYSTEM. Part III.	5. TYPE OF REPORT & PERIOD COVERED FINAL TECHNICAL REPORT. Sep 75 - Jun 76,
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) REINHOLD/REITER RUDOLF/SLADKOVIC	8. CONTRACT OR GRANT NUMBER(s) DAERO-75-G042 new
9. PERFORMING ORGANIZATION NAME AND ADDRESS INSTITUT FUR ATMOSPHARISCHE UMWELTFORSCHUNG de FRAUNHOFER-GESELLSCHAFT D-8100 GARMISCH-PARTENKIRCHEN, GERMANY (West) 282650	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 6 11 02A-1T161102B53B-00-353
11. CONTROLLING OFFICE NAME AND ADDRESS USA R&S GRP (EUR) Box 65, FPO NEW YORK 09510	12. REPORT DATE June 1976
	13. NUMBER OF PAGES 53
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 11 Jul 76	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

12 111p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AEROSOLS; BOUNDARY LAYER;

282650

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The transport of aerosols in a mountain valley has been investigated by means of field experiments. This report is based on eight such experiments, which have been conducted under various meteorological conditions (stability classes B, C, And D after Pasquill, Turner, etc). A complete set of measured data like particle distributions, wind profiles, balloon trajectories, and temperature probings will be presented. The → next page

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

cont.

particle propagation of the single experiment will be compared with the theoretical distribution and influences of valley shape and temperature inversion on the actual distribution will be discussed.

ACCESSION for		
NTIS	White Section	☒
DDC	Buff Section	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	AVAIL. and/or SPECIAL	
A		

-AD__________

BOUNDARY LAYER AEROSOL TRANSPORT MEASUREMENTS IN A VALLEY SYSTEM

Part III

FINAL TECHNICAL REPORT

by

Reinhold Reiter

and Rudolf Sladkovic

July 1976

EUROPEAN RESEARCH OFFICE

United States Army

London W. 1, England

Grant Number DA-ERO-75-G042

Institut für Atmosphärische Umweltforschung

der Fraunhofer-Gesellschaft

D-8100 Garmisch-Partenkirchen, Germany

Kreuzeckbahnstraße 19

Table of contents

ABSTRACT

The transport of aerosols in a mountain valley has been investigated by means of field experiments. This report is based on eight such experiments, which have been conducted under various meteorological conditions (stability classes B, C, And D after Pasquill, Turner, etc). A complete set of measured data like particle distributions, wind profiles, balloon trajectories, and temperature probings will be presented. The particle propagation of the single experiment will be compared with the theoretical distribution and influences of valley shape and temperature inversion on the actual distribution will be discussed.

1. GENERAL REMARKS

The present report includes the results of all eight field measurements which have been accomplished from May 13, 1975 through Augsut 13, 1975 under the conditions described in the last Technical Report (Part II, (0)), paragraph 1. In addition, some conclusions will be drawn, which are, however preliminary ones, since further field measurements will be performed. A final evaluation and conclusion will be prepared after the termination of the field measurements (around summer 1976).

Technical facilities (paragraph 2, Report Part II), aerosol material, and theoretical basis (paragraph 3, Report Part II) have remained unchanged. They have been, however, refined in parts and reference is made in this report where necessary.

The area of the propagation measurements and the location of the aerosol generator remained the same, too.

2. RESULTS OF FIELD EXPERIMENTS

2.0. Format of Presentation

Below a scheme will be commented which will be used to describe all the results of the single field experiments in like manner:

i. General remarks:

a. Distribution of the rotorod sampling devices over the area. Phase I (propagation of the particles between the source and the northern outskirts of Garmisch-Partenkirchen) will be distinguished from Phase II (further distribution over and beyond Garmisch-Partenkirchen and into the branching valleys), see Report Part II *).

b. Meteorological conditions and atmospheric stability with classification resulting from
- Measurements of the wind speed and of the temperature profiles up to 300 m above ground according to Dilger and Nester (1) and Polster (2);
- Cloudiness, wind speed, daytime, and season according to Pasquill (7), Turner (3), Klug (4), and Luna and Church (5).

c. Time and duration of emission

d. Average wind speed between valley floor (= 0 m) and level of the aerosol source (= 300 m) ($\bar{u}$) resulting from ground level measurements and pilot balloon tracking.

---

*) Fig. 17 of Report Part II presents the phases in wrong order: phase II must be phase I and vice versa.

ii. Tables with data as follows:
Coordinates x (distance from source) and y (transverse distance) of the sampling points according to map "Werdenfelser Land" - Bayer. Landesvermessungsamt München, 1:25000. The positions of the sampling point of each experiment have been marked on the maps too (see iv.).
- Column D_{40} and D_{60}: number of fluorescent particles which have been collected at the sampling points after an emission time of 40 or 60 minutes. D_{60} has also been calculated from an emission time of 40 minutes:
$D_{60} = D_{40} \times 60/40$ to make possible the comparison of the results.
- Column $S\bar{u}$: the following formula has been applied to calculate the values

$$S\bar{u} = \frac{D60 \cdot \bar{u}}{\eta \cdot V}$$

S Particle concentration $\left[\text{particles/m}^3\right]$

$\bar{u}$ mean wind speed between 0 - 300 m above ground

η efficiency of the rotorods, after Leighton (6) = 50%

V air throughput of a rotorod, after Leighton (6): $V = 1{,}3\ m^3/h$

There are different values for $\bar{u}$ in Oberau, Farchant, Institute etc, which have been considered in the calculation.
The dimension of $S\bar{u}$ is $\left[\text{particles/m}^2 \cdot s\right]$ based on D_{60} $\left[\text{particles/h}\right]$, V $\left[m^3/h\right]$ and $\bar{u}$ $\left[m/s\right]$.

iii. Plot of $S\bar{u}$ as a function of x and y, a graph with cross sections and a graph with longitudinal sections are added.

iv. Map with number of particles marked at the positions of the rotorods.

v. Profiles of wind speeds measured with pilot balloons.

vi. Trajectories of the pilot balloons on the map.

vii. Radiosonde data in form of lapse rates.

Diagrams iii to vi can be found in the figure-supplement.

2.1 Experiment No. 1 of May 13, 1976

The positions of the sampling sites are the same as in the experiment of March 7, 1975 (Fig. 19, last report).

Meteorological conditions:

cloud cover: 8/10 - 10/10 Cu

cloud height: 1600-2500 m a.s.l.

wind direction: NW - NE

mean wind speed between 0-300 m above ground: Oberau $\bar{u}$ = 3,2 m/s

atmospheric stability: adiabatic with tendency towards slight instability

stability class: D (C)

height of temperature inversion or isotherm: 1300 m above ground

Duration of emission: 12.35 - 13.35 CET (60 min)

Results:

Table No. 1

Figures: 1 - 9

Table 1

13 May 1975

Number of counted particles per collection point

coll. point	distance x [m]	distance y [m]	altid. [m] a.s.l.	Δh^{*} [m]	D_{60}	SŪ
A	2100	0	650	300	921	4534
B	3200	0	653	297	547	2693
C	4500	600	655	295	415	2043
D	4500	400	655	295	501	2466
E	4500	0	659	291	753	3707
F	4500	-225	662	288	732	3606
G	4500	-400	662	288	822	4047
H	5900	0	667	283	566	2786
I	7300	500	677	273	1158	5700
J	7300	300	677	273	1327	6533
K	7300	0	678	272	1331	6553
L	7300	-250	683	267	1346	6631
M	7300	-500	686	264	828	4076
N	9300	500	692	258	1511	7439
O	9300	300	690	260	1410	6941
P	9300	0	688	262	1347	6631
Q	9300	-200	685	265	1330	6550
R	9300	-500	685	265	1191	5863
S	14500	0	740	210	1046	5149
T	7500	3100	1780	-830	205	1009

* Height difference between source and collection point

2.2 Experiment No. 2 of July 26, 1975

Due to a significant meandering of the particle plume in the valley, which has been observed during our last experiment, the measurements 2100 m and 5900 m in front of the source did not yield useful results. These sampling sites have not been used again, but at a distance of 3200 m 3 sites have been set up.

Meteorological conditions:

cloud cover: 1/10 - 2/10 Cu

cloud height: 2000-2500 m a.s.l.

wind direction: N - NE

mean wind speed between 0-300 m above ground: Oberau $\bar{u}$ = 5,0 m/s
Farchant $\bar{u}$ = 6,2 m/s

atmospheric stability: slightly instable to instable

stability class: C (B)

height of temperature inversion or isotherm: 220-450 m above ground

Duration of emission: 11.00 - 12.00 CET (60 min)

Results:

Table No. 2

Figures 10 - 17

Table 2

26 June 1975

Number of counted particles per collection point

coll. point	distance x[m]	distance y[m]	altid. [m] a.s.l.	Δh^* [m]	D_{60}	$S\bar{u}$
A	3200	750	653	297	56	431
B	3200	300	653	297	713	5485
C	3200	0	653	297	814	6261
D	4500	600	655	295	414	3185
E	4500	350	655	295	608	4677
F	4500	0	659	291	605	4654
G	4500	-200	662	288	439	3377
H	4500	-400	662	288	294	2261
I	7300	500	677	273	495	4721
J	7300	300	677	273	540	5150
K	7300	0	678	272	490	4674
L	7300	-250	683	267	482	4597
M	7300	-500	686	264	568	5418
N	9300	500	692	258	411	3920
O	9300	300	690	260	439	4187
P	9300	0	688	262	458	4368
Q	9300	-200	685	265	617	5885
R	9300	-500	685	265	588	5608
S	14500	0	740	210	679	5223
T	8000	3000	1780	-830	29	45

* Height difference between source and collection point

2.3 Experiment No. 3 of July 7, 1975

The positions of the sampling sites are the same as in experiment 2.

Meteorological conditions:

cloud cover: 1/10 - 2/10 Cu

cloud height: 2500 m a.s.l.

wind direction: N - NE

mean wind speed between 0-300 m above ground: Oberau $\bar{u}$ = 3,5 m/s
Farchant $\bar{u}$ = 6,5 m/s

atmospheric stability: instable

stability class: B

height of temperature inversion or isotherm: 830-950 m above ground

Duration of emission: 11.10 - 12.10 CET (60 min)

Results

Table No. 3

Figures 18 - 24

Table 3

7 July 1975

Number of counted particles per collection point

coll. point	distance x[m]	distance y[m]	altid. [m] a.s.l.	Δh* [m]	D_{60}	$S\bar{u}$
A	3200	750	653	297	191	1028
B	3200	300	653	297	596	3209
C	3200	0	653	297	870	4685
D	3200	-1100	656	294	279	1502
E	4500	600	655	295	243	1308
F	4500	350	655	295	287	1545
G	4500	0	659	291	373	2008
H	4500	-400	662	288	362	1949
I	7300	600	677	273	245	2450
J	7300	350	677	273	248	2480
K	7300	0	678	272	291	2910
L	7300	-250	683	267	283	2830
M	7300	-450	686	264	268	2680
N	9300	500	692	258	206	2060
O	9300	300	690	260	208	2080
P	9300	0	688	262	225	2250
Q	9300	-200	685	265	239	2390
R	9300	-500	685	265	269	2690
S	14500	0	740	210	238	1281
T	8000	3000	1780	-830	260	400

* Height difference between source and collection point

2.4 Experiment No. 4 of July 9, 1975

13 rotorods have been set up in phase I (Loisach Valley) and 5 rotorods in phase II (Garmisch-Partenkirchen) to find suitable sampling sites for future experiments in phase II.

Meteorological conditions:

cloud cover: 3/10 Sc, Cu + 8/10 Ac

cloud height: 2200 m + 2800 m a.s.l.

wind direction: N - NE

mean wind speed between 0-300 m above ground: Oberau $\bar{u}$ = 4,0 m/s
Farchant $\bar{u}$ = 5,6 m/s

atmospheric stability: slightly instable to adiabatic

stability class: C - D

height of temperature inversion or isotherm: 300 + 600 + 950 m above ground

Duration of emission: 11.30 - 12.30 CET (60 min)

Results:

Table No. 4

Figures: 25 - 31

Table 4

9 July 1975

Number of counted particles per collection point

coll. point	distance x[m]	distance y[m]	altid. [m] a.s.l.	Δh* [m]	D_{60}	$S\bar{u}$
A	3200	750	653	297	1298	7987
B	3200	0	653	297	1301	8006
C	3200	-1100	656	294	363	2234
D	4500	600	655	295	981	6037
E	4500	0	659	291	720	4431
F	4500	-400	662	288	684	4209
G	7300	600	677	273	683	5884
H	7300	200	677	273	790	6806
I	7300	-200	683	267	544	4687
J	7300	-400	686	264	390	3360
K	9300	500	692	258	418	3601
L	9300	0	688	262	487	4196
M	9300	-500	685	265	492	4238
N	10800	2000	780	170	161	990
O	11000	4500	820	130	21	129
P	14500	0	740	210	661	4068
Q	14500	-500	740	210	322	1981
R	14500	-1800	800	150	148	910

* Height difference between source and collection point

2.5 Experiment No. 5 of July 23, 1975

This experiment has been carried out in phase I due to strong atmospheric instability (intense sunshine). Most of the rotorods have been set up close to the source to pick up the concentration maximum.

Meteorological conditions:

cloud cover: 1/10 - 2/10 Cu

cloud height: 2500 m a.s.l.

wind direction: NE

mean wind speed between 0-300 m above ground: Oberau $\bar{u}$ = 4,9 m/s
Farchant $\bar{u}$ = 5,7 m/s

atmospheric stability: instable

stability class: B

height of temperature inversion or isotherm: 670-770 m above ground

Duration of emission: 12.04 - 13.04 CET (60 min)

Results:

Table No. 5

Figures: 32 - 39

Table 5

23 July 1975

Number of counted particles per collection point

coll. point	distance x[m]	distance y[m]	altid. [m] a.s.l.	Δh* [m]	D_{60}	$S\bar{U}$
A	1600	250	650	300	313	2360
B	1600	0	650	300	837	6310
C	1600	-300	651	299	658	4960
D	3200	750	653	297	234	1764
E	3200	300	653	297	762	5744
F	3200	0	653	297	673	5073
G	3200	-400	655	295	651	4907
H	3200	-1100	656	294	438	3302
I	4500	600	655	295	357	2691
J	4500	0	659	291	427	2319
K	4500	-200	662	288	528	3980
L	4500	-400	662	288	538	4055
M	7300	600	677	273	224	1964
N	7300	200	677	273	382	3350
O	7300	-200	683	267	553	4850
P	7300	-400	686	264	535	4691
Q	9300	500	692	258	184	1613
R	9300	0	688	262	324	2858
S	9300	-500	685	265	331	2903
T	8000	3000	1780	-830	43	66

* Height difference between source and collection point

2.6 Experiment No. 6 of July 28, 1976

12 sampling sites have been chosen in phase II, but still 7 in the Loisach valley to allow a comparison with former results.

Meteorological conditions:

cloud cover: 1/10 - 2/10 Cu

cloud height: 2700 m a.s.l.

wind direction: N - NE

mean wind speed between 0-300 m above ground: Farchant $\bar{u}$ = 6,8 m/s
Institute $\bar{u}$ = 5,2 m/s

atmospheric stability: slightly instable to instable

stability class: C (B)

height of temperature inversion or isotherm: 470 + 900 m above ground

Duration of emission: 12.00 - 12.40 CET (40 min)

Results:

Table No. 6

Figures: 40 - 47

Table 6

28 July 1975

Number of counted particles per collection point

coll. point	distance x[m]	distance y[m]	altid. [m] a.s.l.	Δh^* [m]	D_{40}	D_{60}	$S\bar{u}$
A	3200	0	653	297	257	385	3080
B	7300	600	677	273	218	327	3421
C	7300	0	678	272	327	490	5126
D	7300	-400	686	264	517	777	8129
E	9300	500	692	258	252	378	3954
F	9300	0	688	262	351	526	5503
G	9300	-500	685	265	376	564	5900
H	12000	2800	780	170	112	168	1344
I	12000	1400	707	243	129	193	1544
J	12000	850	707	243	208	312	2496
K	12000	0	707	243	482	723	5784
L	12000	-700	715	235	393	590	4720
M	16500	0	770	180	466	700	5600
N	16500	-1200	740	210	450	675	5400
O	Eckbauer		1200	-250	35	53	163
P	Wamberg		1050	-100	51	76	234
Q	Hausberg		1330	-380	79	118	363
R	Kreuzjoch		1700	-750	135	202	621
S	Kreuzeck		1650	-700	127	190	585

* Height difference between source and collection point

2.7 Experiment No. 7 of 6 August, 1975

4 sampling sites have been chosen in the Loisach valley, but 15 in phase II. 4 sites have been located in Grainau, because a second concentration maximum has been observed there.

Meteorological conditions:

cloud cover: 3/10 - 4/10 Cu

cloud height: 2500 m a.s.l.

wind direction: N - NE

mean wind speed between 0-300 m above ground: Burgrain $\bar{u}$ = 6,7 m/s
Institute $\bar{u}$ = 4,6 m/s

atmospheric stability: indifferent to slightly instable

stability class: D (C)

height of temperature inversion or isotherm: 320 m above ground

Duaration of emission: 11.30 - 12.10 CET (40 min)

Results:

Table No. 7

Figures: 48 - 55

Table 7

6 Aug 1975

Number of counted particles per collection point

coll. point	distance x[m]	distance y[m]	altid. [m] a.s.l.	Δh^* [m]	D_{40}	D_{60}	$S\bar{u}$
A	7300	0	678	272	436	654	6741
B	9300	500	692	258	344	516	5319
C	9300	0	688	262	390	585	6030
D	9300	-500	685	265	455	682	7030
E	12000	3000	800	150	66	99	700
F	12000	2100	715	235	119	179	1266
G	12000	1300	707	243	267	400	2831
H	12000	600	707	243	416	624	4416
I	12000	0	707	243	597	895	6333
J	12000	-700	715	235	573	859	6079
K	16000	1700	900	50	472	708	5010
L	16500	900	800	150	546	819	5796
M	16500	0	770	180	425	637	4437
N	16500	-1200	740	210	272	408	2887
O	8000	3000	1780	-830	28	42	130
P	Eckbauer		1200	-250	53	80	246
Q	Bayernhaus		1250	-300	170	255	785
R	Garmischerhaus		1330	-380	169	254	781
S	Kreuzjoch		1700	-750	107	160	492
T	Kreuzeck		1650	-700	155	232	714

* Height difference between source and collection point

2.8 Experiment No. 8 of August 13, 1975

The positions of the sampling sites are the same as in experiment No. 7 (phase II).

Meteorological conditions:

cloud cover: 4/10 - 5/10 Cu

cloud height: 2500 m a.s.l.

wind direction: N - NE

mean wind speed between 0-300 m above ground: Burgrain $\bar{u}$ = 6,1 m/s
Institute $\bar{u}$ = 3,0 m/s

atmospheric stability: slightly instable

stability class: C

height of temperature inversion or isotherm: 200 +670 m above ground

Duration of emission: 12.00 - 12.40 CET (40 min)

Results:

Table No. 8

Figures: 56 - 63

Table 8
13 Aug 1975

Number of counted particles per collection point

coll. point	distance x [m]	distance y [m]	altid. [m] a.s.l.	Δh^* [m]	D_{40}	D_{60}	$S\bar{u}$
A	7300	0	678	272	94	141	1323
B	9300	500	692	258	68	102	957
C	9300	0	688	262	108	162	1520
D	9300	-500	685	265	310	465	4364
E	12000	2800	780	170	39	58	267
F	12000	2000	710	240	50	75	346
G	12000	1300	707	243	122	183	845
H	12000	600	707	243	154	231	1060
I	12000	0	707	243	215	322	1486
J	12000	-700	715	235	330	495	2285
K	16500	900	800	150	302	453	2090
L	16500	0	770	180	345	517	2386
M	16500	-1200	740	210	438	657	3032
N	14500	-1800	800	150	726	1089	5026
O	8000	3000	1780	-830	22	33	101
P	Eckbauer		1200	-250	23	34	104
Q	Bayernhaus		1250	-300	97	145	446
R	Garmischerhaus		1330	-380	103	154	473
S	Kreuzjoch		1700	-750	98	147	452
T	Kreuzeck		1650	-700	123	184	566

* Height difference between source and collection point

3. COMMENTARY

In figures 64 - 66 for all experiments the concentration distributions in the plume axis on ground level are presented as functions of the distance from the source. The graphs also show two theoretical curves, which have been calculated with the Pasquill formula in the axis and on the ground (Report, Part II, formula (5))

$$S\bar{u} = \frac{E}{\pi \sigma_y \sigma_z} \exp - \frac{H^2}{2 \sigma_z^2}$$

S	particle concentration [particles /m^3]
$\bar{u}$	mean wind speed between ground and source height [m/s]
E	emission rate 1,42 g/s = 1,3 . 10^{10} particles /s
σ_y, σ_z	diffusion coefficients in the direction of y and z [m]
H	effective height of the source [m]; figures as Δh in the tables of the results

This diffusion model thus assumes complete ground absorption, i.e. all released particles which contact the ground will be caught there. Diffusion coefficients have been used according to Pasquill (7) and Turner (11) and according to Novicki (9). Pasquill coefficients have been calculated with an effective height of a source of 107 m and a roughness $z_o \approx$ 0,1 - 0,2 m. In our experiments the height of the source is about 300 m and the roughness of the Loisach valley and of Garmisch-Partenkirchen is z_o = 0.44 m. These real conditions have been considered in the calculation of the coefficients according to Nowicki. The mean propagation coeffi-

cients for the atmospheric layer between ground and source height can be calculated with the following formulae (Nowicki (9)):

$$\bar{\sigma}_{y_{0-H}} = 0.08 \left(6\,m^{-0.3} + 1 - \ln \frac{H}{z_0} \right) x^{0.367(2.5m)}$$

$$\bar{\sigma}_{z_{0-H}} = 0.38\,m^{1.3} \left(8.7 - \ln \frac{H}{z_0} \right) x^{1.55\exp(-2.35m)}$$

x	distance from the source [m]
z_o	height of surface roughness [m]
H	effective height of the source [m]
m	meteorological exponent, depending on the atmospheric equilibrium

The mean m-values as a function of the stability class are

class	V	B	C	D	E	F
m	0.08	0.143	0.196	0.270	0.365	0.440

4. CONCLUSIONS

4.0 In most cases presented in Figs. 64 - 66 there is an obvious influence of the valley slopes on the particle propagation in the valley. The limiting value for the start of this effect (i.e. measured particle concentration greater than calculated) is that distance from the source, where $4.3\,\sigma_y$ equals the width of the valley ($4.3\,\sigma_y = R$). After this distance the particle plume will contact the valley

slopes, and characteristic values are 3 - 3.5 km for condition B, 5 - 5.5 km for condition C, and 8 - 9 km for condition D. These limits are depicted as short vertical bars in Figs. 64 - 66 intersecting the theoretical curves.

4.1 Up to the distance where $4.3\ \sigma_y = R$ the propagation of the particles in a mountain valley is the same as in the open country and the transverse concentration distribution agrees well with a Gaussian distribution. Fig. 67 presents some of these concentration distributions close to the source.

4.2 At distances with $4.3\ \sigma_y > R$ the particle concentration usually exceeds the theoretical value for the open country, reaching a distinct maximum at 7 - 9 km. Simultaneously the Gaussian profile of the concentration distribution alters in favour of a uniform distribution. Fig. 68 shows some plume cross sections at distances of 7.3 and 9.3 km: the particle concentration from slope to slope of the valley is almost homogeneous apart from some minor and local maxima. The particle current fills the whole width of the valley.

4.3 Temperature inversions, too, affect the propagation of the dispersed particles in a mountain valley (see longitudinal sections, Figs. 10, 25, 48). This influence - which can cause a second maximum of the particle concentration (D) in the plume axis - is very well revealed by the experiments of June 26 and July 9, 1975 (class C), and by the experiment of August 6, 1975 (class D). This effect is very pronounced whenever the inversion is directly above the source. An increase of this influence with increasing distance from the source can lead to a second and intense concentration maximum, as can be seen in the experiment of July 9, 1975, where a second maximum has developed in a distance x = 14.5 km from the source.

4.4 Contrary to the open country conditions an inversion and the narrowness of a valley cause an increase of the particle concentration in a mountain valley. Other factors, however, like vertical and horizontal meandering of the plume, cause a concentration reduction in the valley.

The horizontal meandering of the wind in the Loisach valley is well indicated in all balloon trajectories (see first of all balloon trajectories, Figs. 29,36) and all experiments show a shift of the maximum particle concentration out of the plume axis. This horizontal meandering just causes a very intense and fast propagation of the dispersed particles within a short distance from the source (up to $4.3_y = R$). Such a meandering of the plume has also been observed in the experiments by Hovind (8) and Start (10).

Some of the experiments also revealed a vertical fluctuation of the plume in the vicinity of the source. This phenomenon (experiment March 7, 1975, Report, Part II and experiment May 15, 1975 in this report) has been regarded as an irregular high concentration close to the source. This observation has been confirmed by means of three constant-level balloons. The balloons have been started at source level, they soon sank to a level of 100 to 50 m above ground before ascending again. This phenomenon is caused by a sinking of the air current at the lee-side of the release mountain thus producing particle concentrations which do not agree with the theoretical distribution. (Figs. 29, 36).

4.5 A specific propagation of dispersed particles in a mountain valley is, to a high degree, caused by an inhomogeneous wind field. In diffusion equations independence of the mean wind speed from the geographic coordinates is assumed. This assumption is a good approximation for open country conditions, but it does not suffice in the mountains. The wind forms during sunny mornings in the Loisach vallley north of the release mountain, accelerates in the valley,

reaches a maximum at the end of the valley and slows down in the basin of Garmisch-Partenkirchen. Characteristic average wind profiles are presented in Fig. 69 in distances of 3.2 km, 7.3 km, and 14.5 km from the release mountain (class C for instance). This figure shows in the valley at a distance of 3.2 km from the source, a homogeneous wind speed up to an altitude of 500 to 600 m, a decrease above towards a calm between 1000 and 1300 m, and geostrophic wind above the calm.
At a distance of 7.3 km from the source, there is a significant increase of the wind speed with a maximum between 200 and 300 m above ground and the calm is found already between 900 and 1100 m.

In the basin of Garmisch-Partenkirchen the wind speed decreases again and the calm is at a still lower level of 800 to 1000 m: the geostrophic wind penetrates here into lower altitudes. These two facts most probably cause the high particle concentrations at large distances from the source (12, 14.5, and 16.5 km) in the basin of Garmisch-Partenkirchen. It could be established that most of the particles propagate with the valley wind and that there is no perpendicular spreading (see the results on the peaks of Wank, Eckbauer, and Kreuzeck). Descending valley wind causes an increase of the particle concentration and declining wind causes slower propagation. Both factors therefore cause a second or even a third concentration maximum at large distances from the source, contrary to the theoretical conception.

It is of interest that the driving force of this mechanism is the sunshine intensity and not the direction of the geostrophic wind. Even a geostrophic west current (i.e. transverse to the valley wind) cannot stop the wind in the basin of Garmisch-Partenkirchen (e.g. in the experiment of July 28, 1975, the geostrophic wind was from W, in the experiments

of June 26, July 9, and August 13, 1975, the geostrophic wind was from NW).

4.6 The vertical wind profile in a mountain valley is very specific and distinguished from a profile above the open country which can be described with an exponential or logarithmic equation (see Fig. 69). Moreover, this profile is subject to quick variations with time and space. The determination of the mean wind speed in the atmospheric layer between ground and effective source level is therefore very difficult in this case and should be based on a coincidental checking of the atmosphere. For a certain valley the total wind rose must be determined too. All other wind roses, even from nearby stations which are, however, situated beyond the valley, will lead to completely different and erroneous results.

5. COLLECTION OF AEROSOL PARTICLES ON FILTERS

At Atmospheric Science Laboratory, White Sands Missile Range, New Mexico, measurements of the refractive index of aerosol samples are conducted of aerosol material which is received from various places of the earth.

For these investigations samples are provided by our Institute of our stations Garmisch-Partenkirchen and Wank peak (lateron Zugspitze, too).

Following is the number of filters exposed at both stations during the contract period:

Garmisch-Partenkirchen (valley) 740 m a.s.l.	10 Apr 75 - 30 Jun 76: 84 filters
Wank peak, 1780 m a.s.l.	20 Apr 76 - 30 Jun 76: 5 filters

Because of the small aerosol concentration at Wank level the filters have to be exposed for 2 - 3 weeks.

Since the beginning of April 1976 we also provide all measuring data obtained at the stations which might be of interest for comparison purposes: Meteorological parameters, aerosol concentration and size distribution, vertical exchange intensity, atmospheric electricity.

.-.-.-.-.-.

The sampling of aerosol particles for the same program at Zugspitze is being prepared and will begin by the end of this summer.

REFERENCES

(0) Reiter, R.
Boundary layer aerosol transport measurements in a valley sytem.
Final Technical Report Part II, Grant Number DA-ERO-124-74-G0054 (1975)

(1) Dilger, H., Nester, K.
Aufstellung und Vergleich verschiedener Schemata zur Bestimmung von Ausbreitungskategorien.
Met. Rdsch. 28, 12 (1975)

(2) Polster, G.
Erfahrungen mit Strahlungs-Temperaturgradient und Windmessungen als Bestimmungsgrössen der Diffusionskategorien.
Met. Rdsch. 22, 170 (1969)

(3) Turner, D.B.
Workbook of atmospheric dispersion estimates.
EPA No. AP-26, Triangle Park (1971)

(4) Klug, W.
Ein Verfahren zur Bestimmung der Ausbreitungsbedingungen aus synoptischen Beobachtungen.
Staub, 29, 4, 143 (1969)

(5) Luna, R.E., and Church, H.W.
A comparison of turbulence intensity and stability ratio measurements to Pasquill stability classes.
J. Appl. Met. 11, 4, 663 (1972)

(6) Leighton, P.A. et al.
The fluorescent particle atmospheric tracer.
J. Appl. Met. 4, 334 (1965)

(7) Pasquill, F.
Atmospheric diffusion.
Von Nostrand Co, London (1968)

(8) Hovind et al.
The influence of rough mountainous terrain upon plume dispersion from an elevated source.
Symp. on Atm. Diff. and Air Poll., S. Barbara (1974)

(9) Nowicki, M.
Ein Beitrag zur Bestimmung universeller Diffusionskoeffizienten.
Arch. Met. Geoph. Biokl. Ser. A (1976) (in press)

(10) Start, G.E. et al.
Diffusion in a canyon with rough mountainous terrain.
NOAA Techn. Memor. ARL-38 (1973)

(11) Turner, D.B.
Workbook of atmospheric dispersion estimates.
EPA, Triangle Park (1970)

LEGENDS OF FIGURES

Type of figures:

I Number of counted particles and product Su particles/m^2. s for cross sections and plume axis

II Number of counted particles per sampling site

III Wind velocity profiles

IV Trajectories of pilot balloons

V Air temperature measurements by radiosonde

Field Exp. No.	Date of Exp.	Type of Figure	No. of Figure
		I	1
		II	2
1	13 May 1975	III	3 - 5
		IV	6 - 8
		V	9
		I	10
		II	11
2	26 June 1975	III	12 - 14
		IV	15 - 16
		V	17
		I	18
		II	19
3	7 July 1975	III	20 - 21
		IV	22 - 23
		V	24
		I	25
		II	26
4	9 July 1975	III	27 - 28
		IV	29 - 30
		V	31

Field Exp. No.	Date of Exp.	Type of Figure	No. of Figure
		I	32
		II	33
5	23 July 1975	III	34 - 35
		IV	36 - 38
		V	39
		I	40
		II	41
6	28 July 1975	III	42 - 43
		IV	44 - 46
		V	47
		I	48
		II	49
7	6 August 1975	III	50 - 51
		IV	52 - 54
		V	55
		I	56
		II	57
8	13 August 1975	III	58 - 59
		IV	60 - 62
		V	63

Fig. 64 a, b — Product Su particles/m^2s for plume axis, stability class B

Fig. 65 a,b,c,d — Same, stability class C

Fig. 66 a, b — Same, stability class D

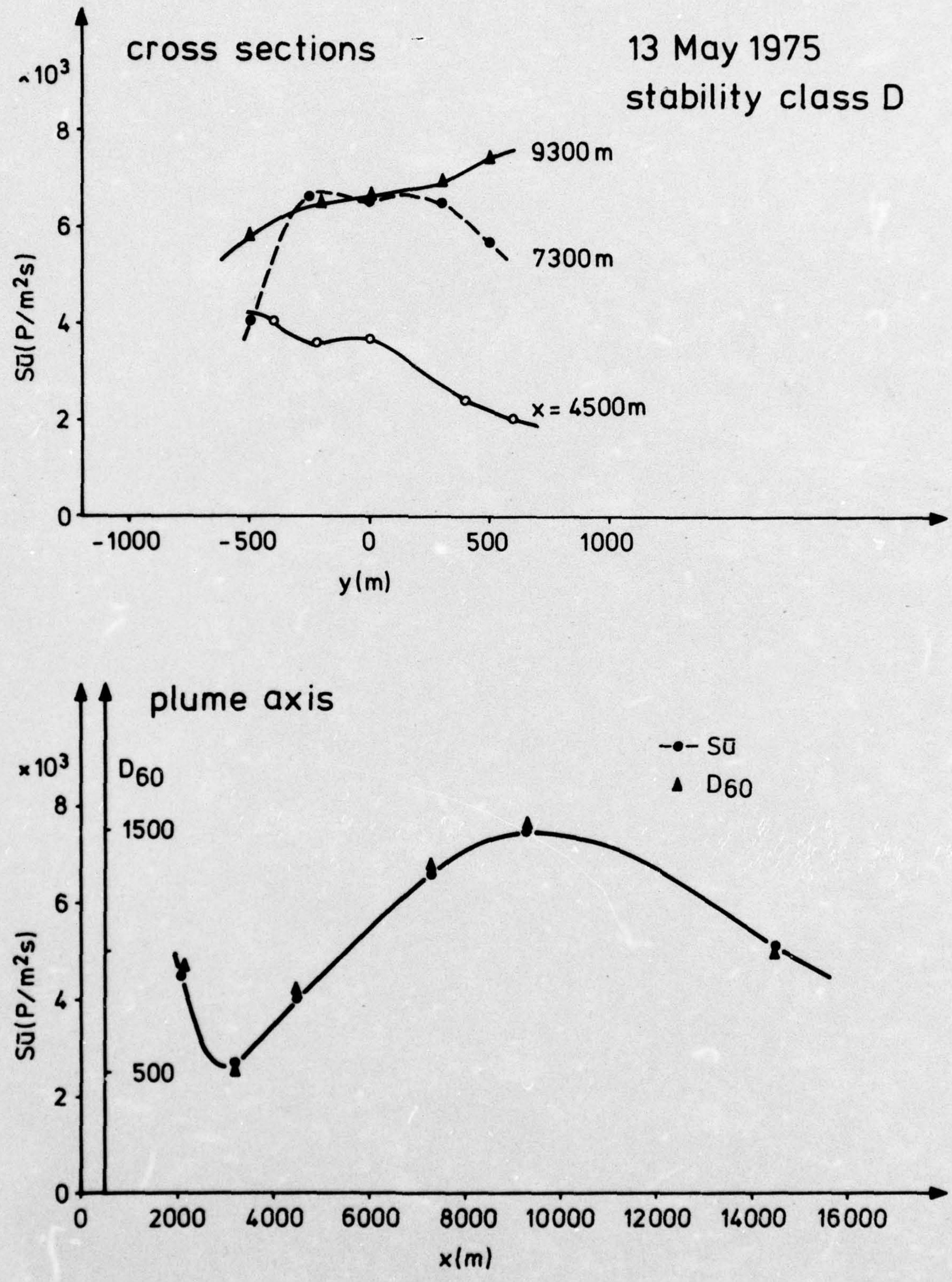
Fig. 67 — Field experiments with Gaussian shape of particle distribution transverse to axis

Fig. 68 — Field experiments without Gaussian shape of particle distribution transverse to axis

Fig. 69 — Wind speed profiles in the valley, stability class C, at 12.30 CET

FIGURES

Fig. 1



cross sections
13 May 1975
stability class D
x10³
8
6
4
2
0
Sū(P/m²s)
9300 m
7300 m
x = 4500 m
-1000
-500
0
500
1000
y(m)
plume axis
x10³
D60
1500
500
-●- Sū
▲ D60
0
2000
4000
6000
8000
10000
12000
14000
16000
x(m)

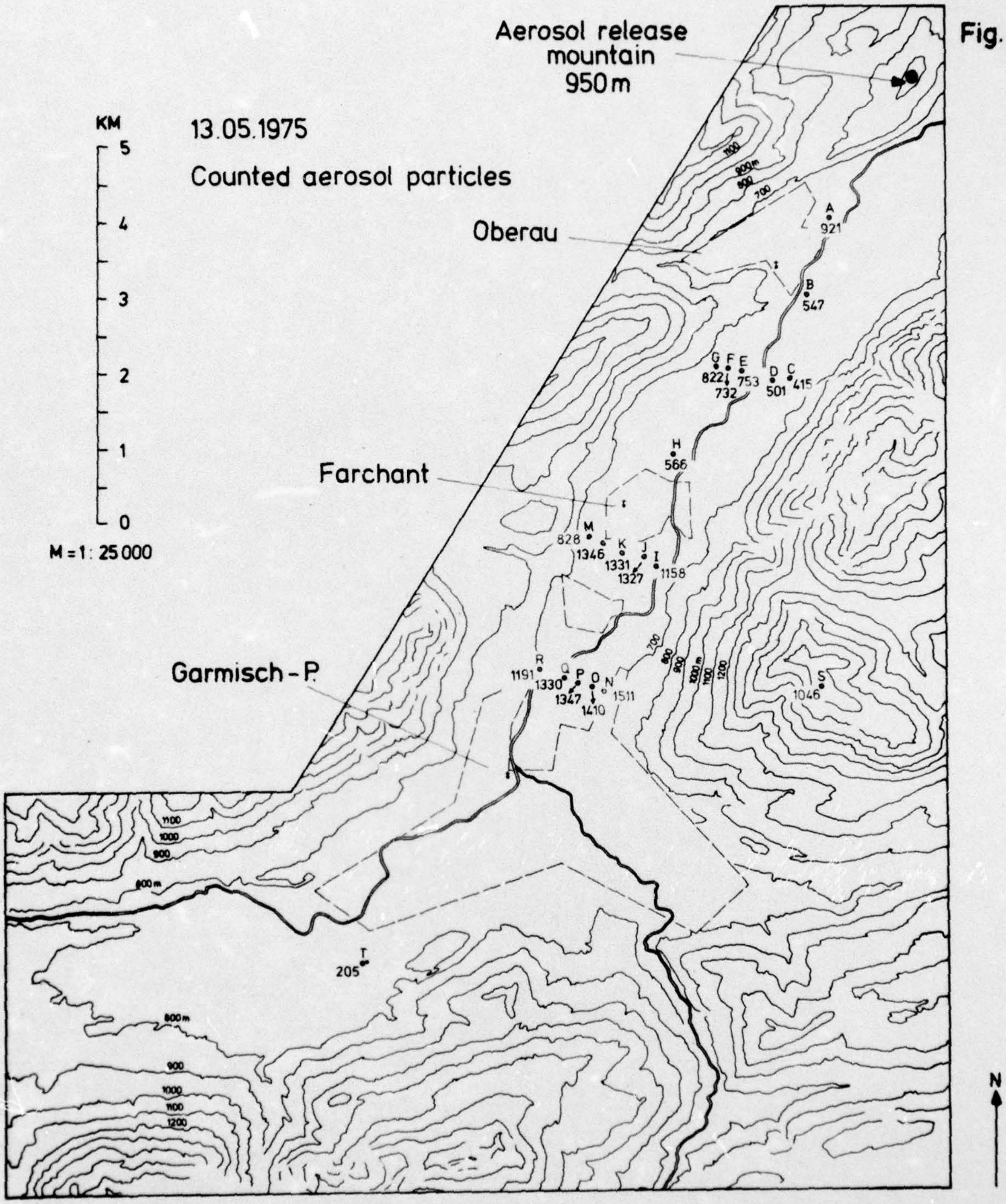
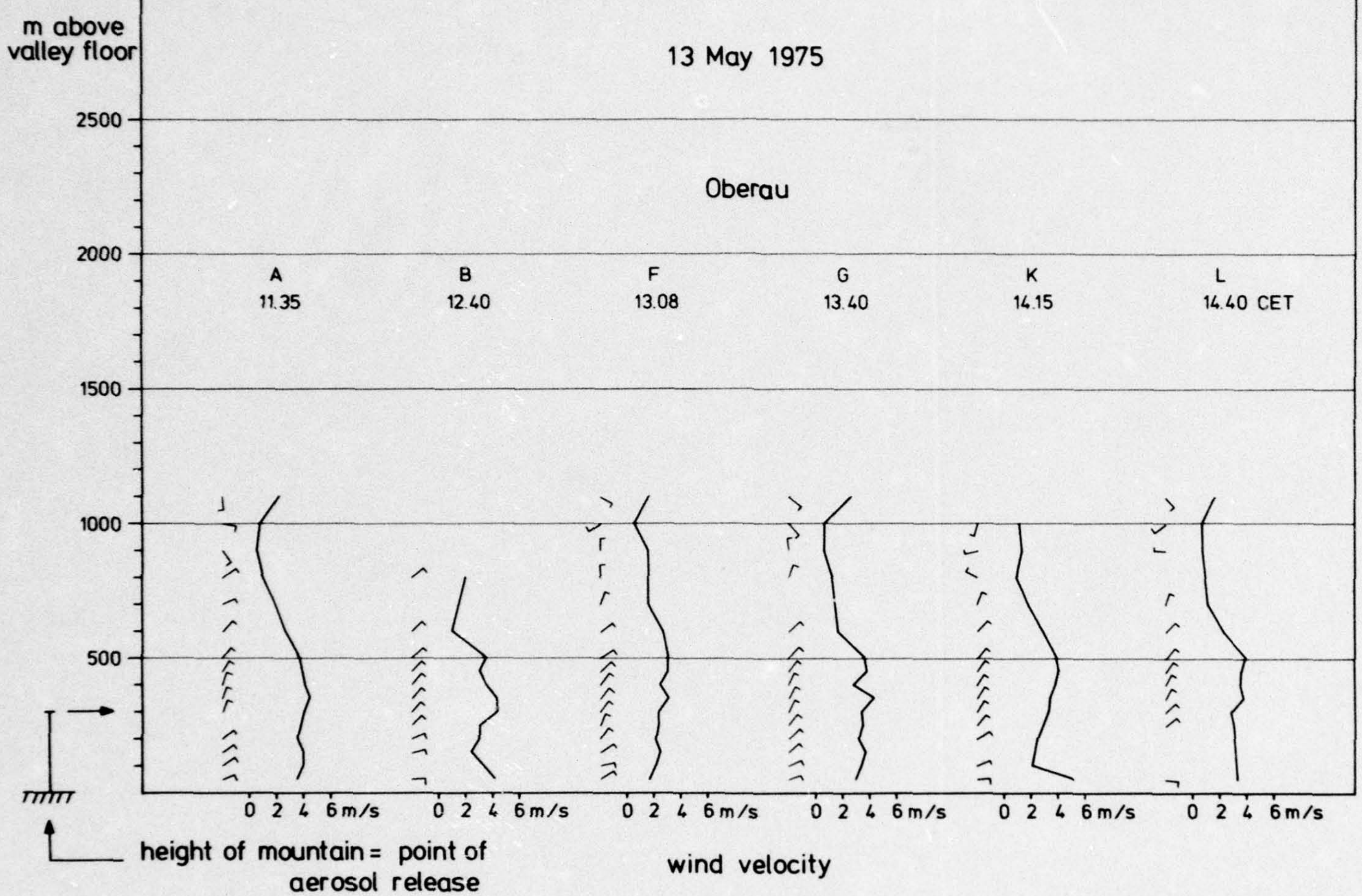
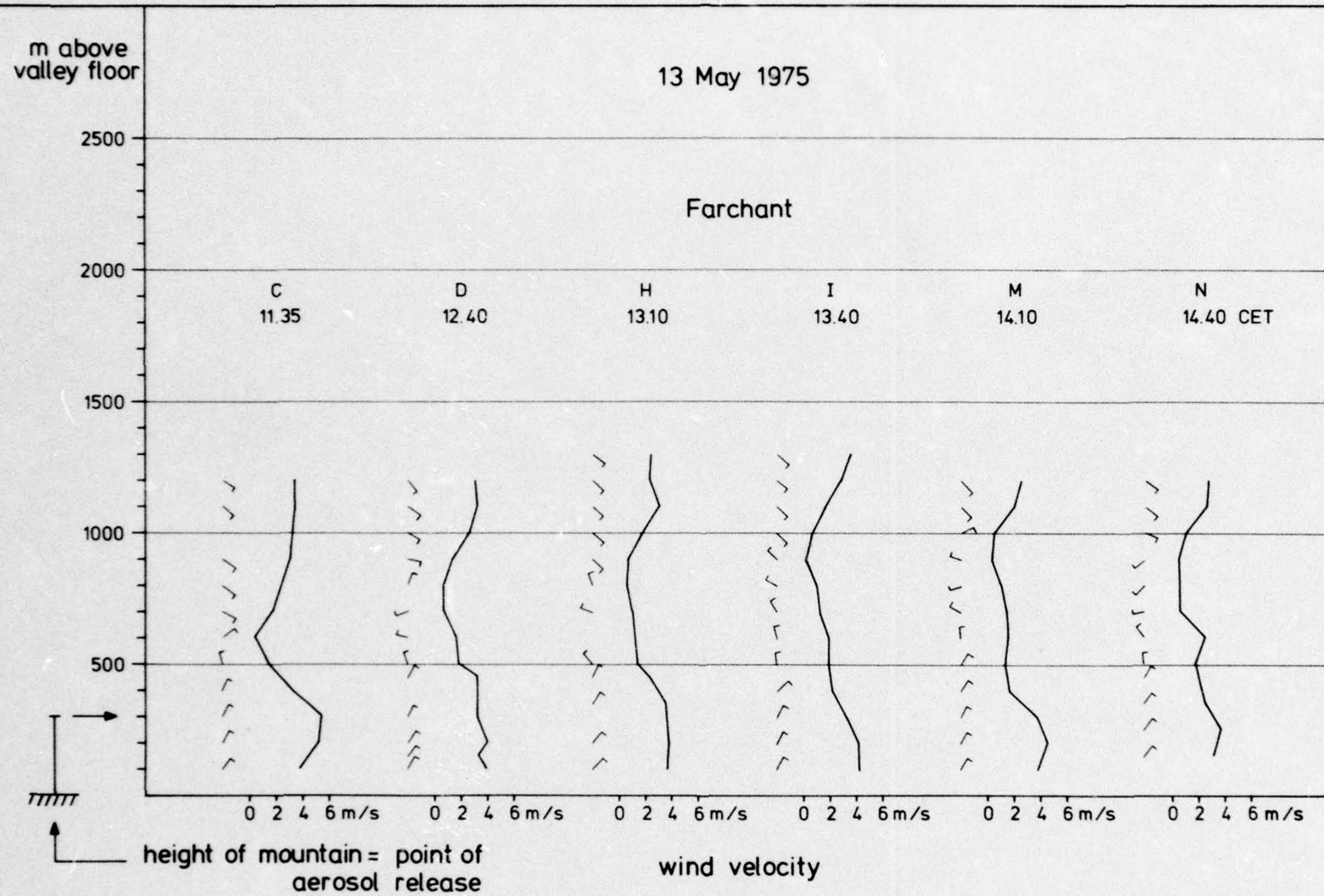

Aerosol release
mountain
950 m
13.05.1975
Counted aerosol particles
KM
5
4
3
2
1
0
M = 1: 25 000
Oberau
Farchant
Garmisch - P.
A 921
B 547
G 822
F 732
E 753
D 501
C 415
H 566
M 828
L 1346
K 1331
J 1327
I 1158
R 1191
Q 1330
P 1347
O 1410
N 1511
S 1046
T 205
N

Fig. 2



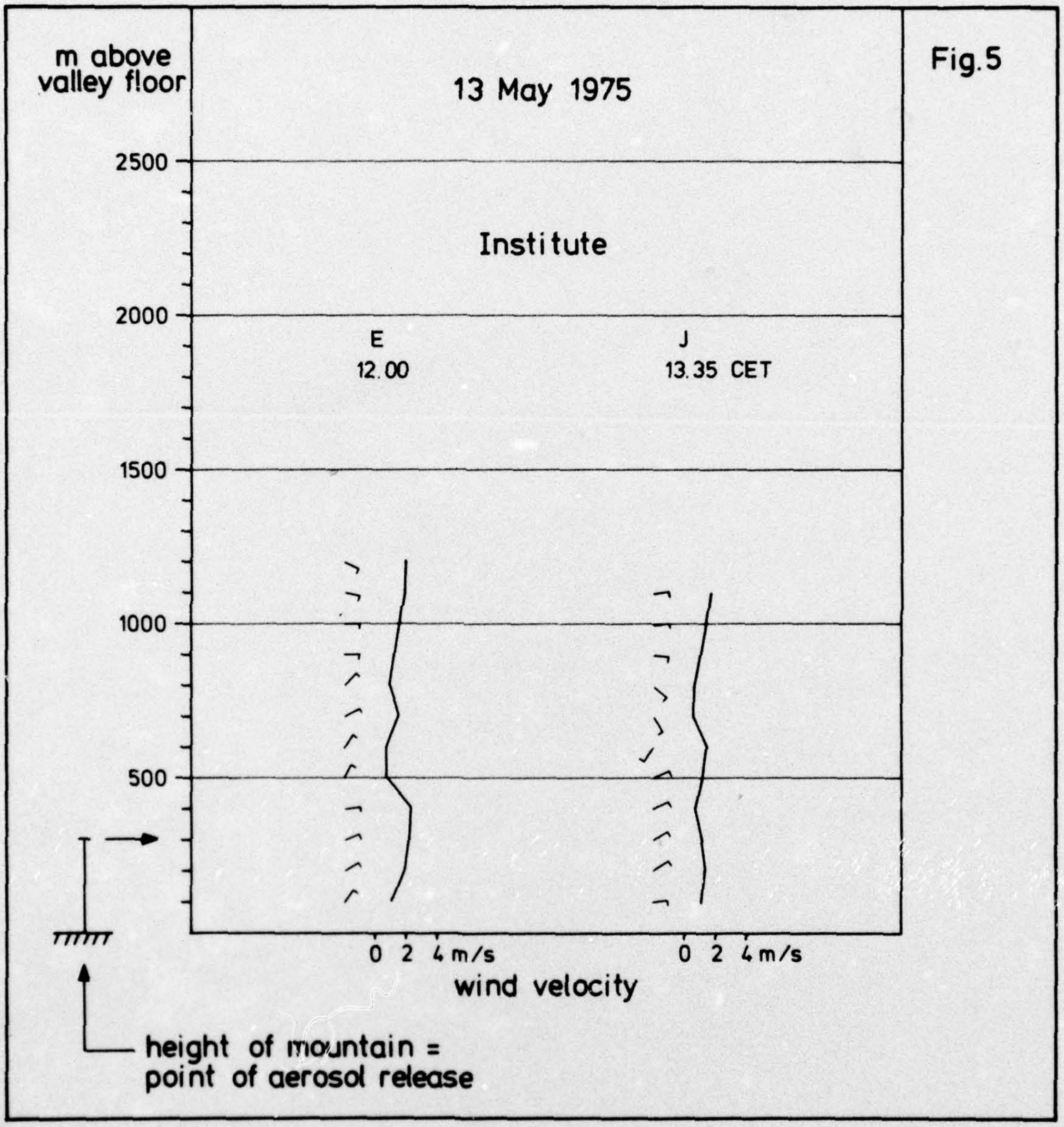
m above valley floor
13 May 1975
Oberau
2500
2000
1500
1000
500
A
11.35
B
12.40
F
13.08
G
13.40
K
14.15
L
14.40 CET
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
height of mountain = point of aerosol release
wind velocity

Fig. 3



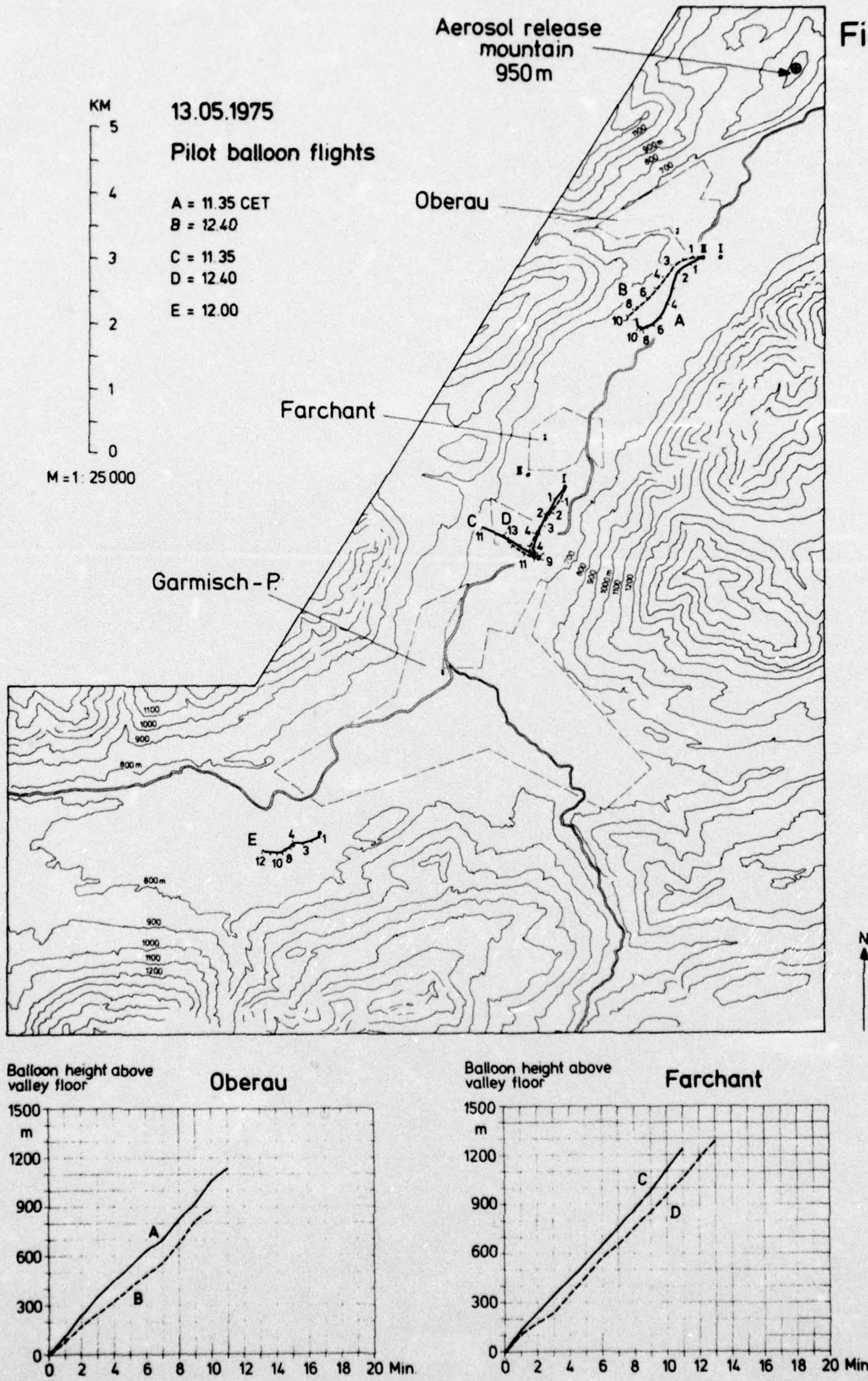
m above
valley floor
13 May 1975
2500
Farchant
2000
C
11.35
D
12.40
H
13.10
I
13.40
M
14.10
N
14.40 CET
1500
1000
500
0 2 4 6 m/s
height of mountain = point of
aerosol release
wind velocity

Fig. 4



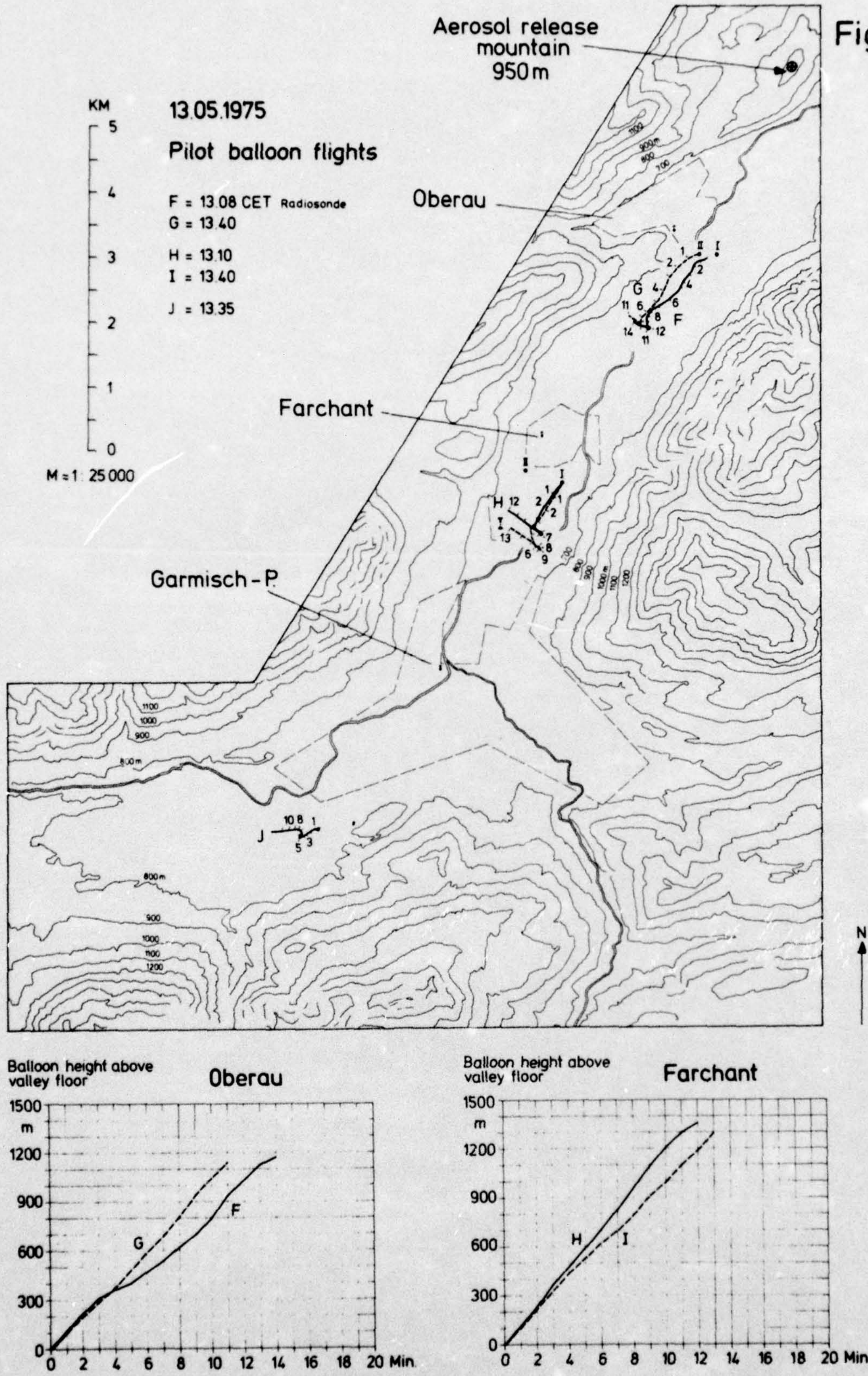
m above
valley floor
13 May 1975
Fig.5
2500
Institute
2000
E
12.00
J
13.35 CET
1500
1000
500
0 2 4 m/s
0 2 4 m/s
wind velocity
height of mountain =
point of aerosol release

Fig.6

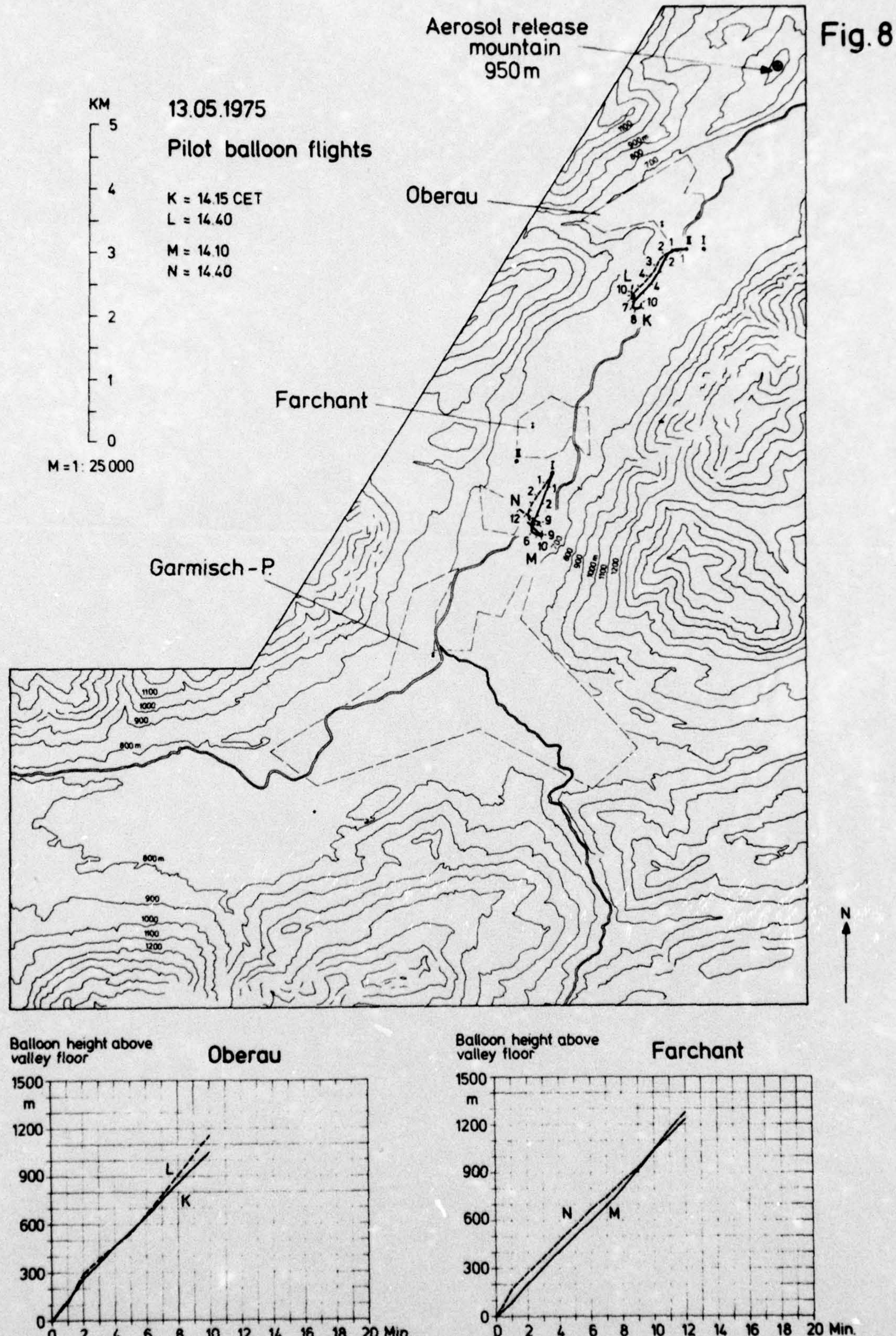


Aerosol release mountain 950m
13.05.1975
Pilot balloon flights
A = 11.35 CET
B = 12.40
C = 11.35
D = 12.40
E = 12.00
KM
M = 1: 25000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Oberau
Farchant
m
Min.

Fig. 7



Aerosol release
mountain
950 m
13.05.1975
Pilot balloon flights
F = 13.08 CET Radiosonde
G = 13.40
H = 13.10
I = 13.40
J = 13.35
KM
M ≈ 1 : 25 000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Oberau
Farchant
m
Min.



Aerosol release
mountain
950 m
Fig. 8
KM
5
4
3
2
1
0
M = 1: 25 000
13.05.1975
Pilot balloon flights
K = 14.15 CET
L = 14.40
M = 14.10
N = 14.40
Oberau
Farchant
Garmisch - P.
N
Balloon height above valley floor
Oberau
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.
L
K
Balloon height above valley floor
Farchant
N
M

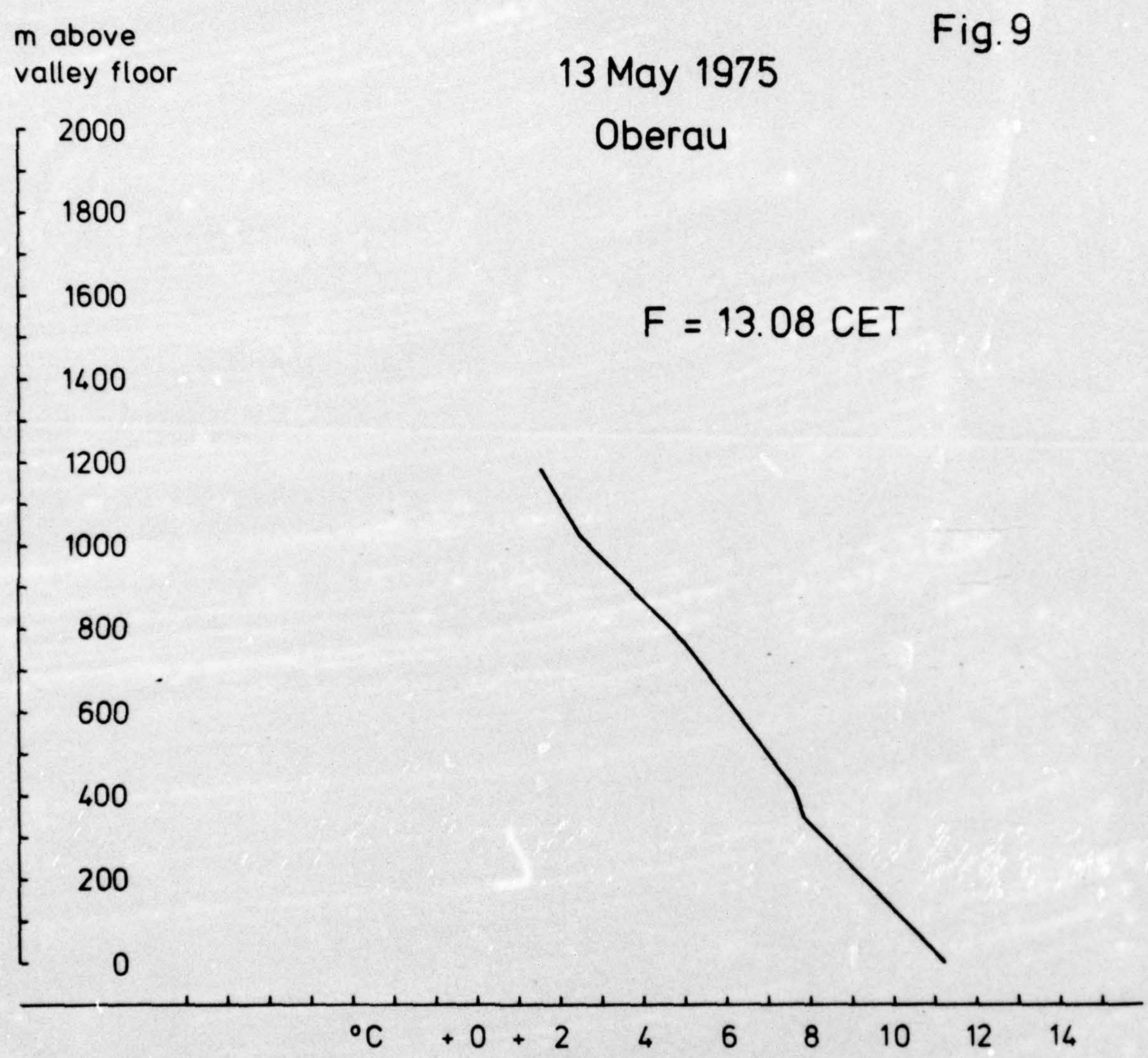
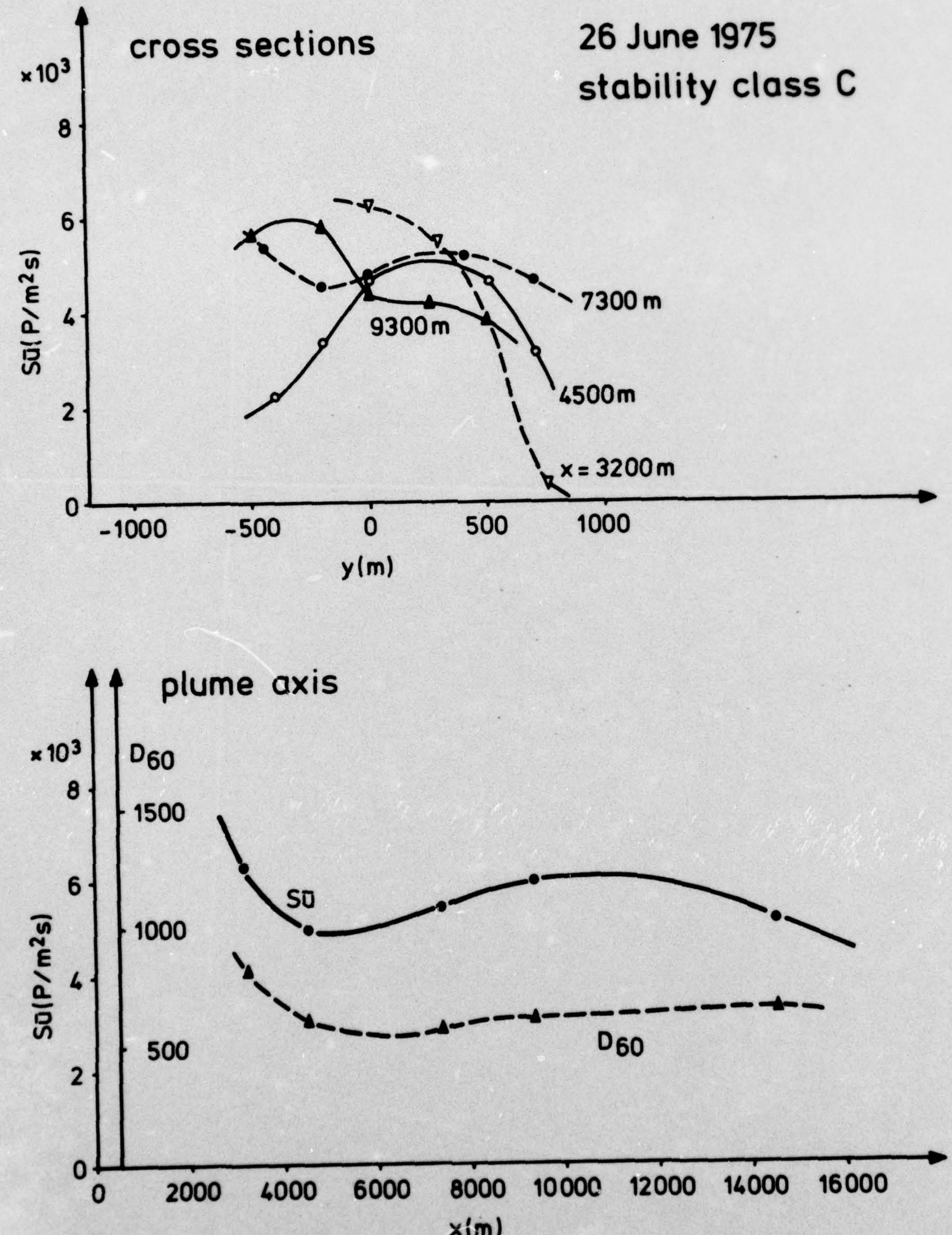
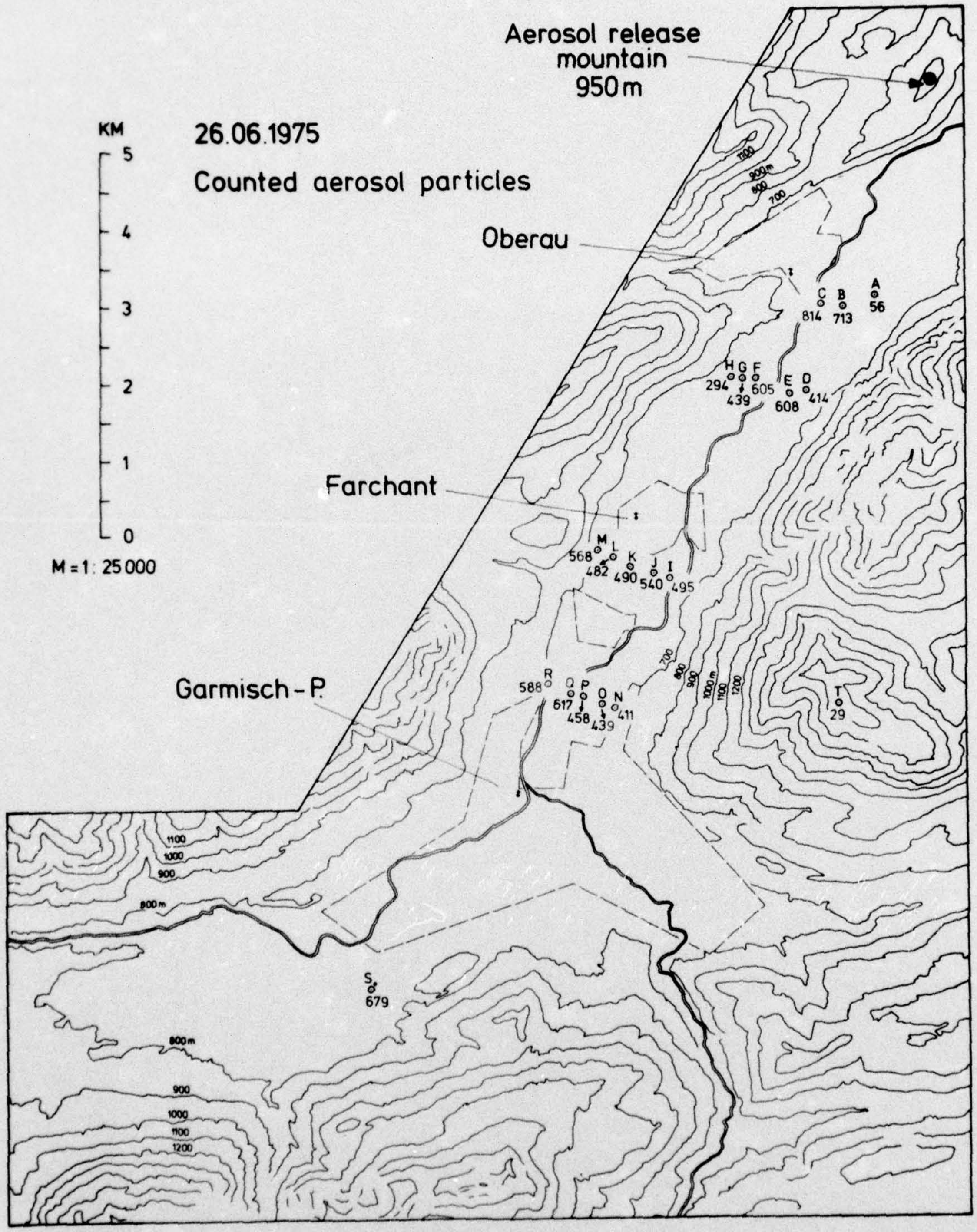

m above
valley floor
Fig. 9
13 May 1975
Oberau
2000
1800
1600
F = 13.08 CET
1400
1200
1000
800
600
400
200
0
°C
+ 0 + 2
4
6
8
10
12
14

Fig.10

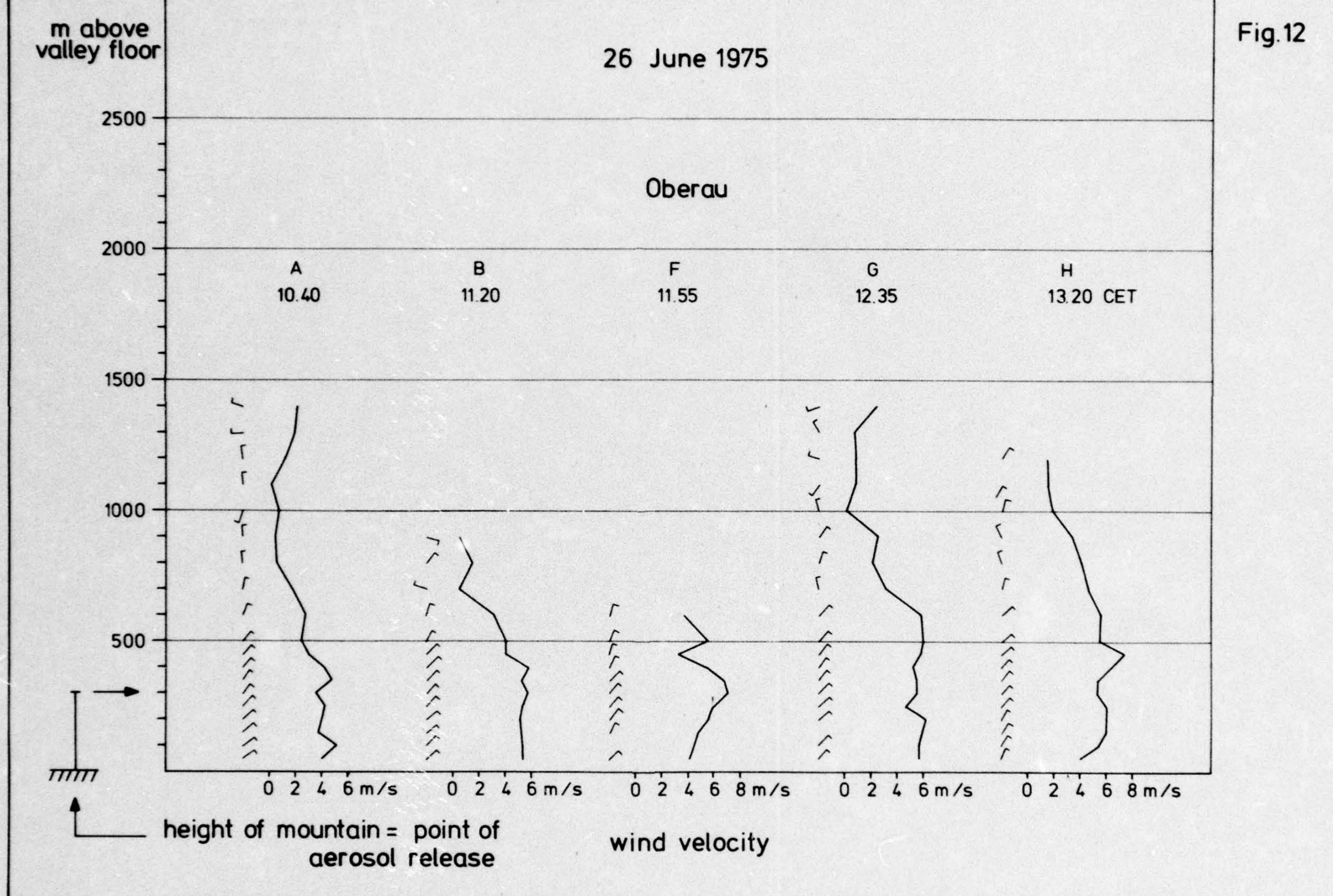

cross sections
26 June 1975
stability class C
x 10³
8
6
4
2
0
Sū (P/m²s)
7300 m
9300 m
4500 m
x = 3200 m
-1000
-500
0
500
1000
y (m)
plume axis
x 10³
D60
8
1500
6
4
2
0
1000
500
Sū
D60
Sū (P/m²s)
0
2000
4000
6000
8000
10000
12000
14000
16000
x (m)



Aerosol release
mountain
950 m
KM
5
4
3
2
1
0
M = 1: 25 000
26.06.1975
Counted aerosol particles
Oberau
Farchant
Garmisch-P.
A
56
B
713
C
814
D
414
E
608
F
605
G
439
H
294
I
495
J
540
K
490
L
482
M
568
N
411
O
439
P
458
Q
617
R
588
S
679
T
29
N

Fig.11

Fig.12


m above valley floor
26 June 1975
2500
Oberau
2000
A
10.40
B
11.20
F
11.55
G
12.35
H
13.20 CET
1500
1000
500
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 m/s
0 2 4 6 8 m/s
height of mountain = point of aerosol release
wind velocity

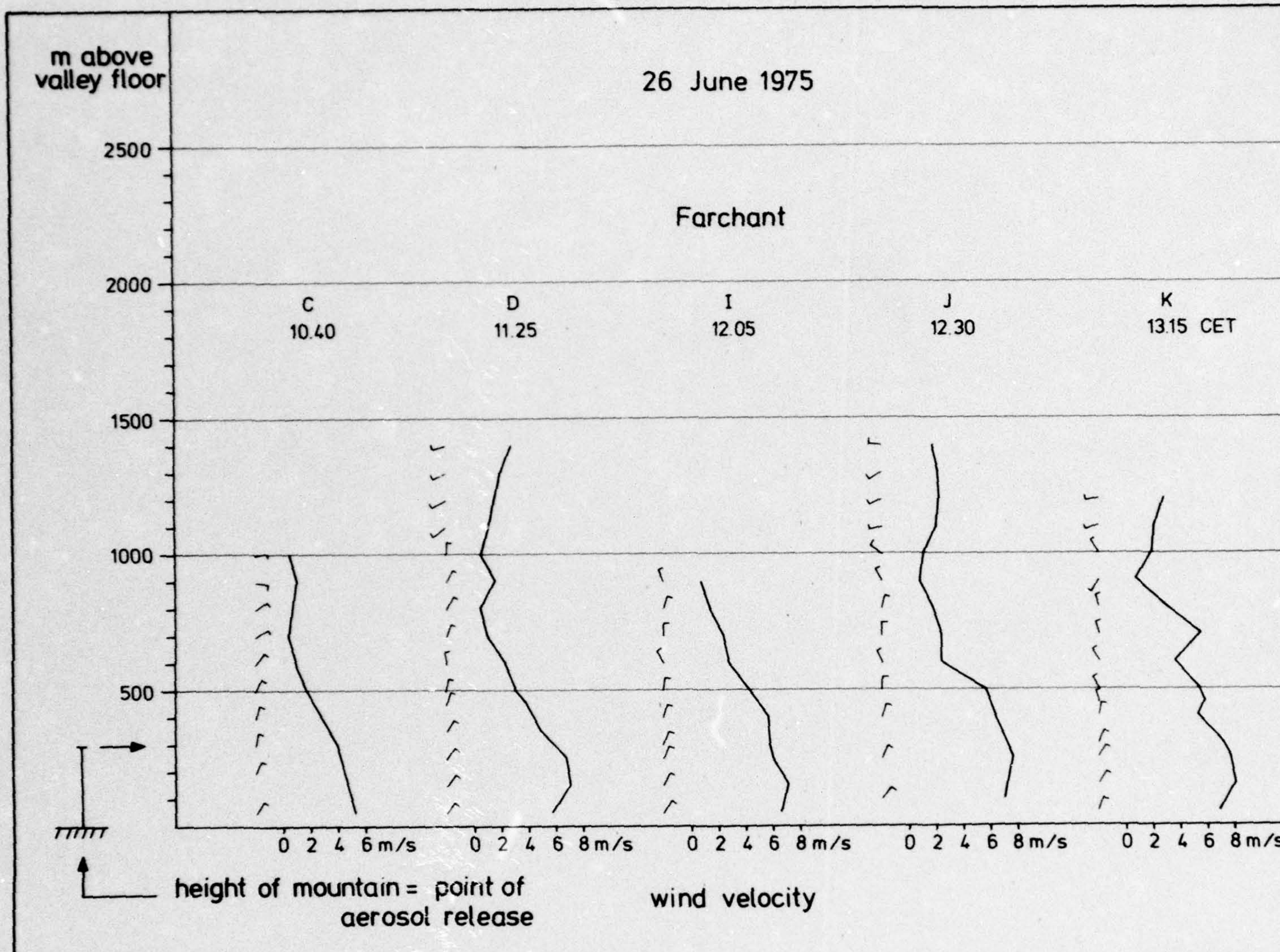
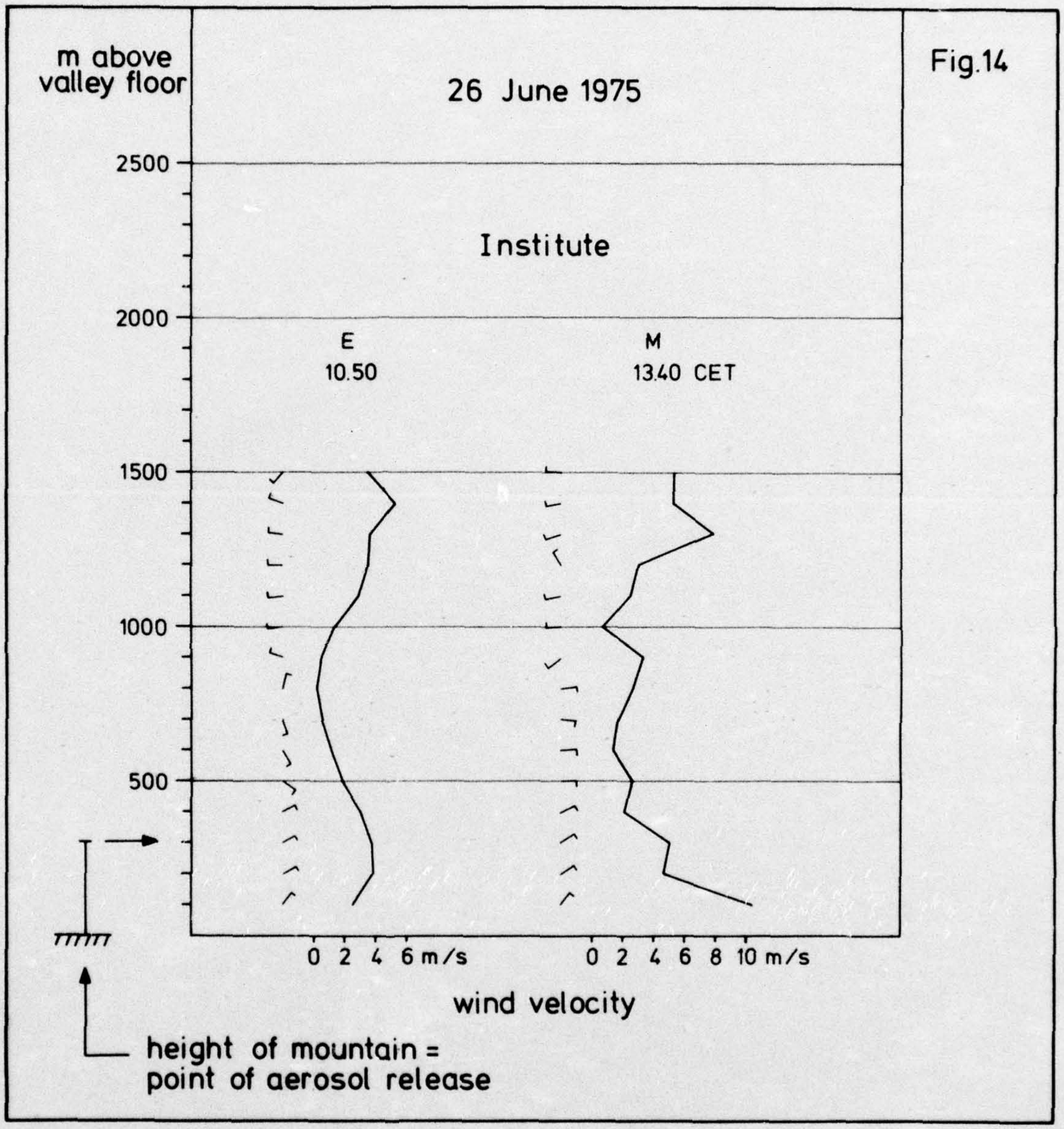
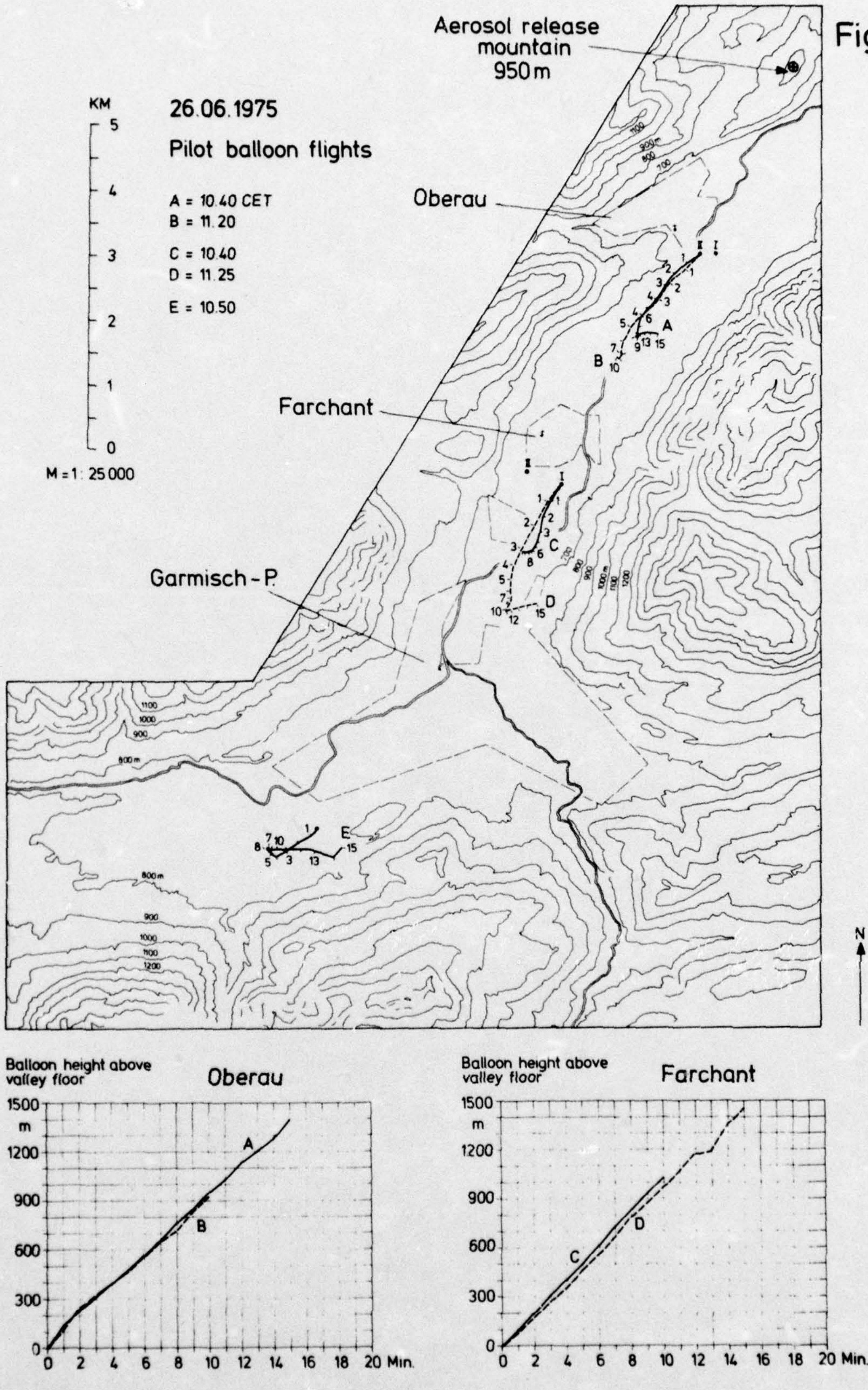

m above valley floor
2500
2000
1500
1000
500
26 June 1975
Farchant
C
10.40
D
11.25
I
12.05
J
12.30
K
13.15 CET
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
height of mountain = point of aerosol release
wind velocity

Fig. 13



m above
valley floor
26 June 1975
Fig.14
2500
Institute
2000
E
10.50
M
13.40 CET
1500
1000
500
0 2 4 6 m/s
0 2 4 6 8 10 m/s
wind velocity
height of mountain =
point of aerosol release



Aerosol release
mountain
950 m
KM
5
4
3
2
1
0
M = 1: 25 000
26.06.1975
Pilot balloon flights
A = 10.40 CET
B = 11.20
C = 10.40
D = 11.25
E = 10.50
Oberau
Farchant
Garmisch - P.
A
B
C
D
E
N
Balloon height above valley floor
Oberau
Farchant
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.

Fig.15

Fig.16

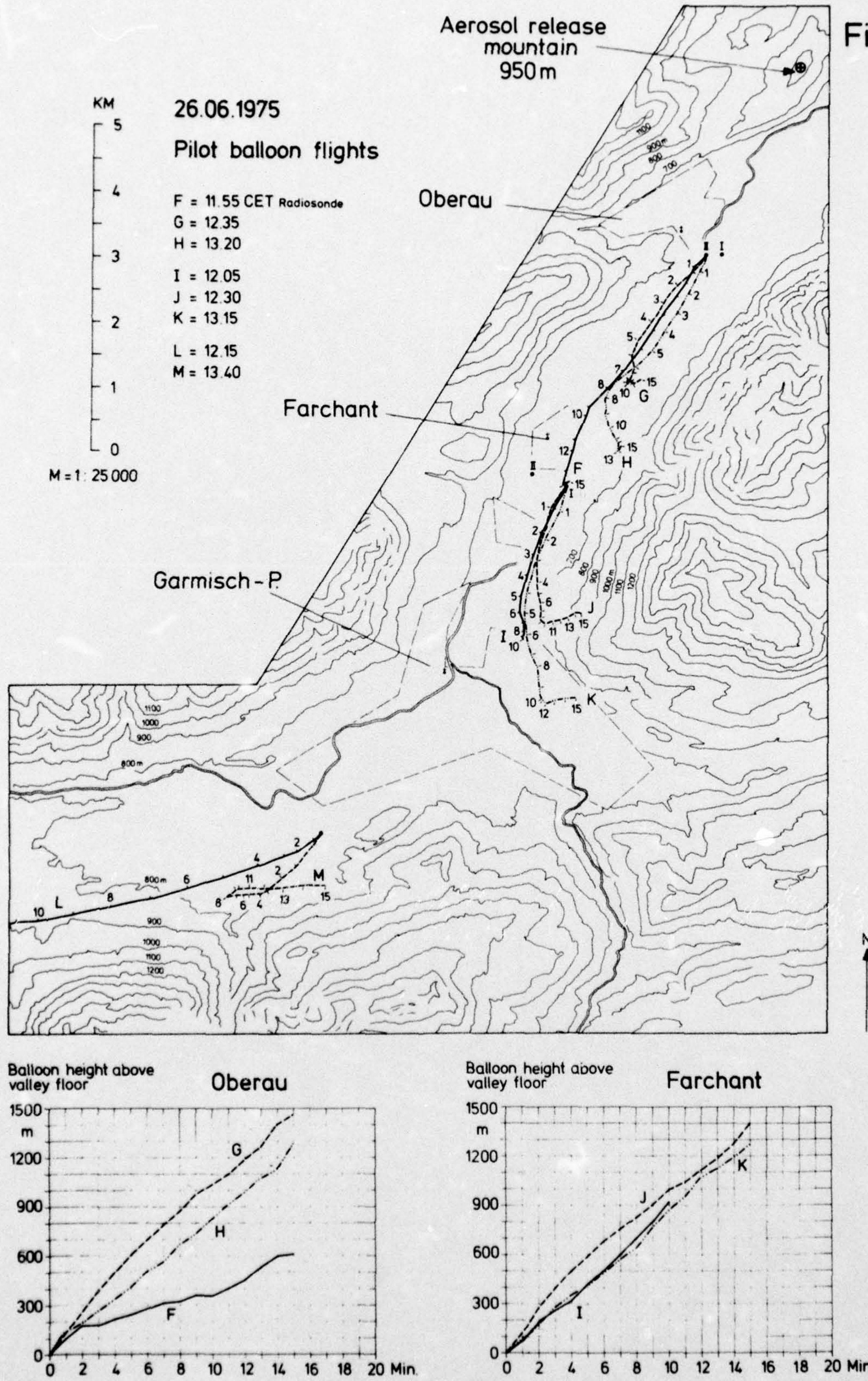

Aerosol release mountain 950m
26.06.1975
Pilot balloon flights
KM
5
4
3
2
1
0
M = 1: 25 000
F = 11.55 CET Radiosonde
G = 12.35
H = 13.20
I = 12.05
J = 12.30
K = 13.15
L = 12.15
M = 13.40
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Oberau
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.
G
H
F
Balloon height above valley floor
Farchant
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.
J
K
I

Fig. 17

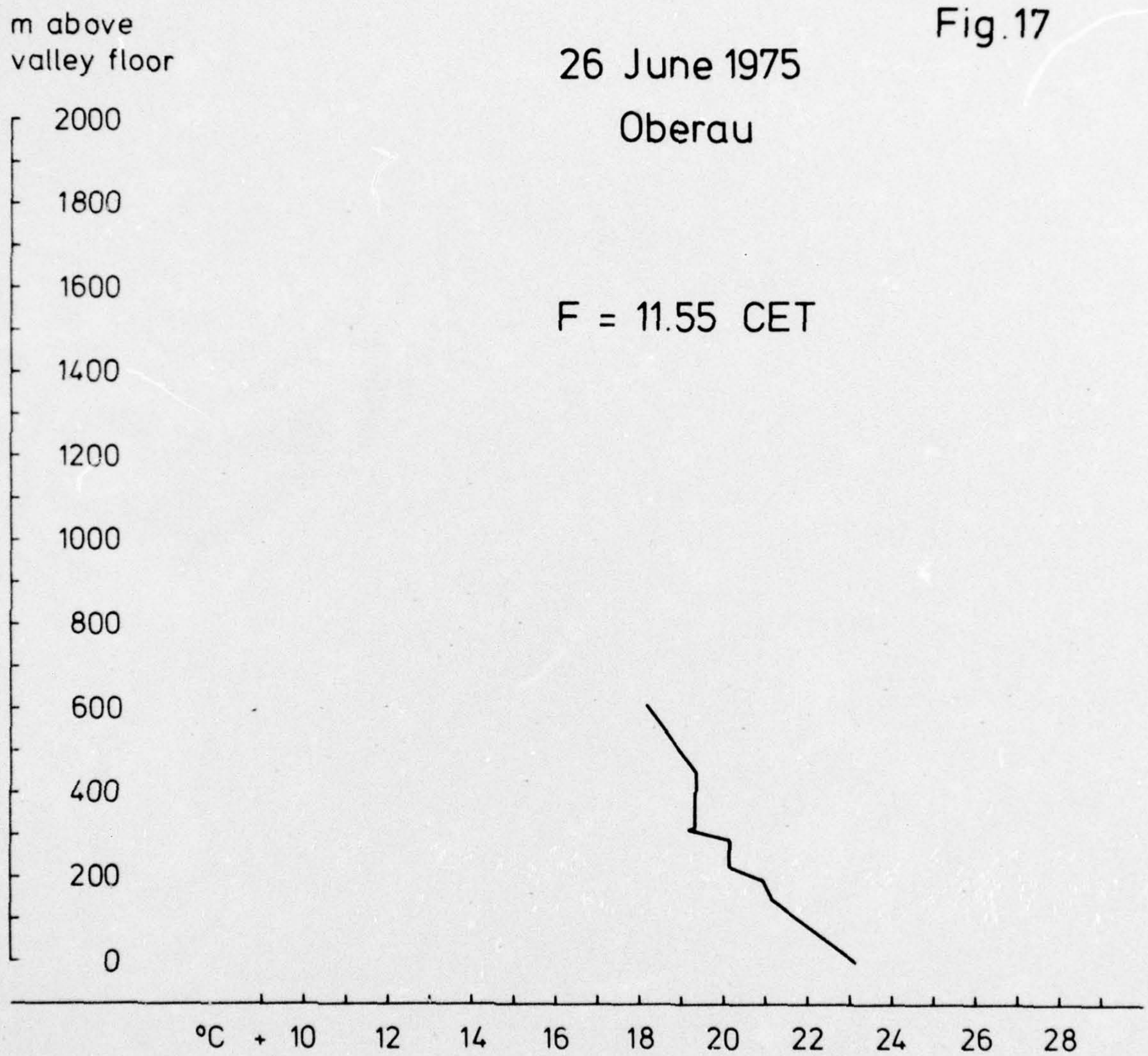
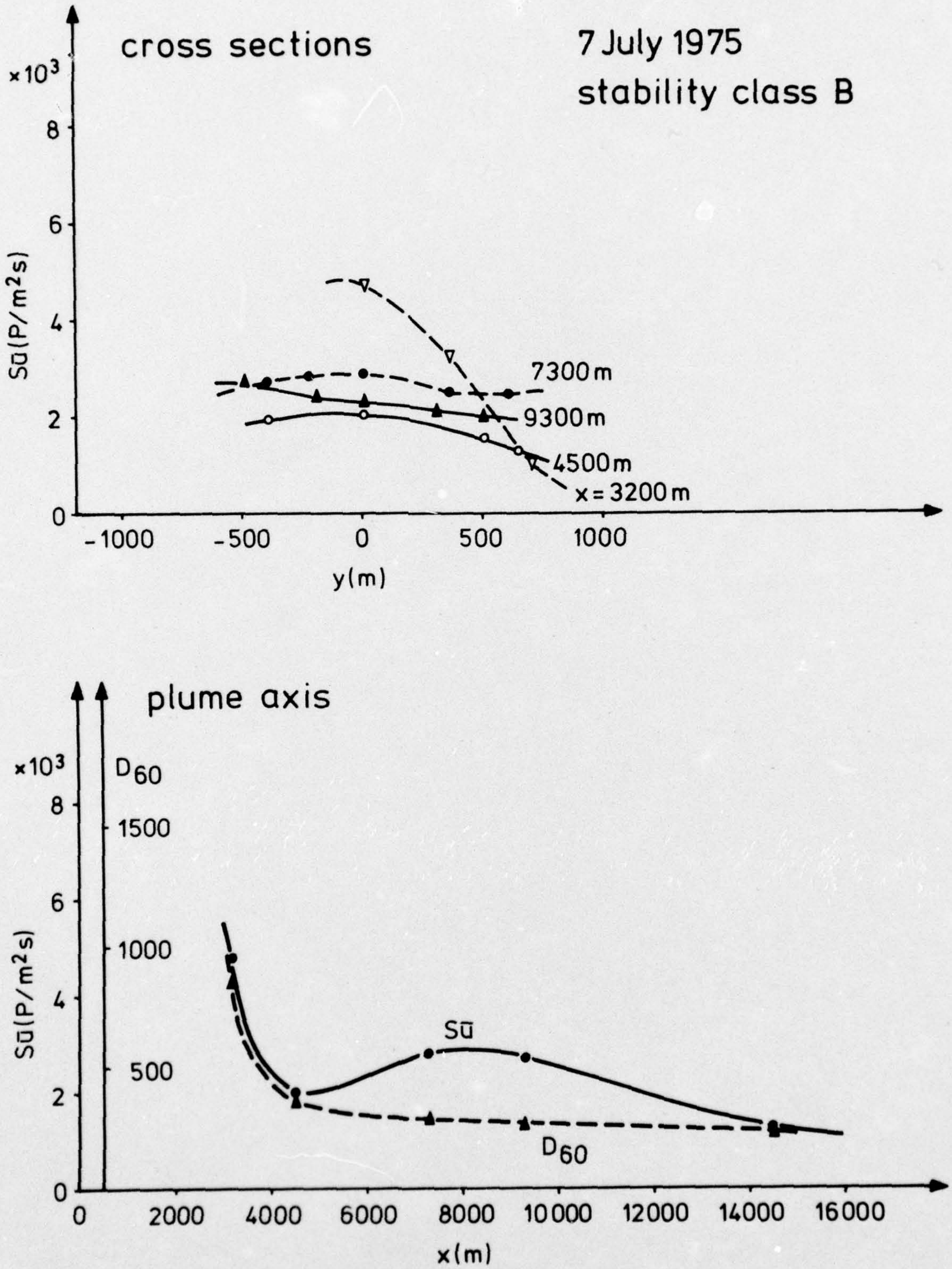
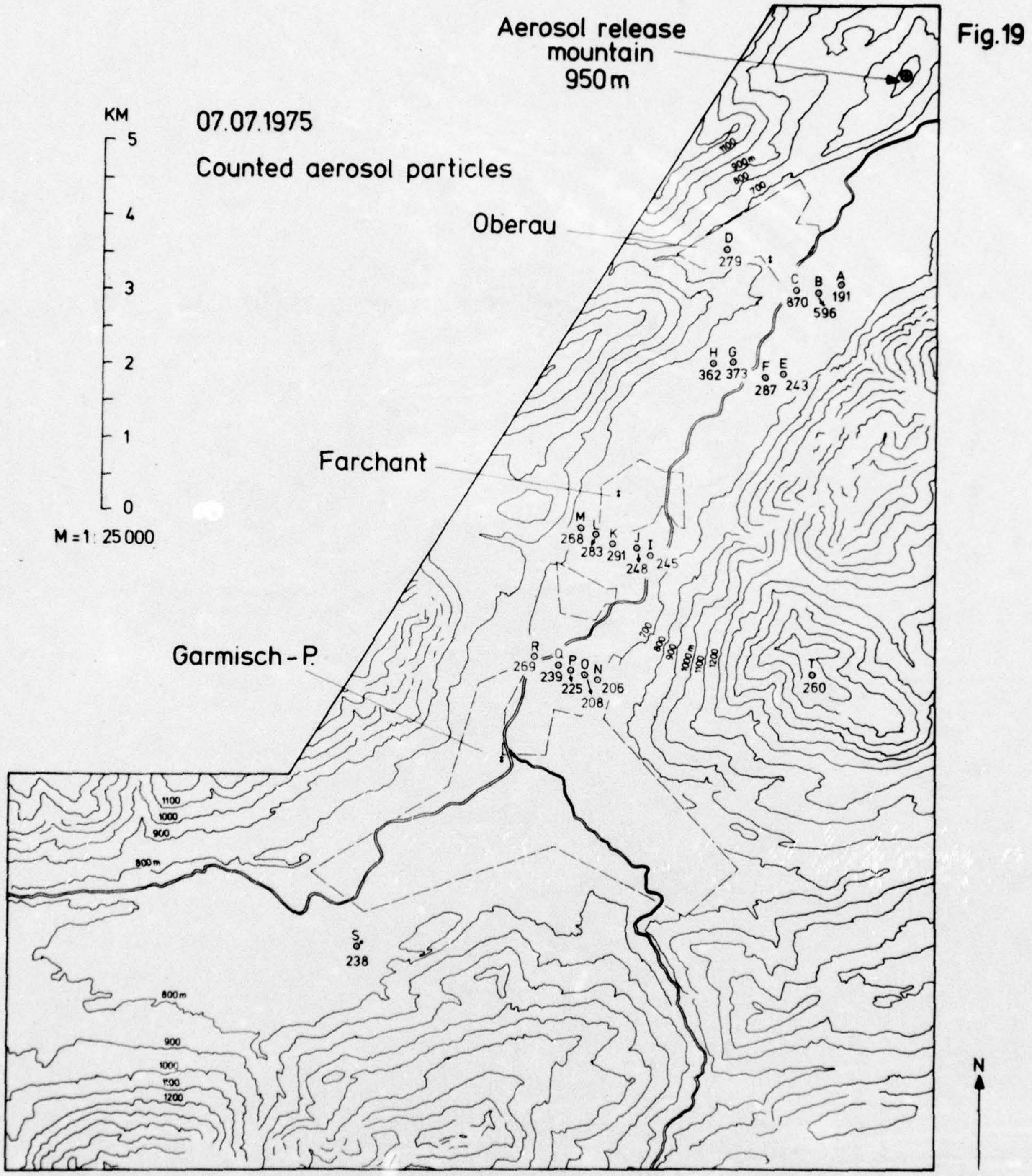

m above
valley floor
2000
1800
1600
1400
1200
1000
800
600
400
200
0
°C + 10
12
14
16
18
20
22
24
26
28
26 June 1975
Oberau
F = 11.55 CET

Fig. 18



cross sections
7 July 1975
stability class B
×10³
Sū (P/m²s)
7300 m
9300 m
4500 m
x = 3200 m
y (m)
plume axis
×10³
D60
Sū (P/m²s)
Sū
D60
x (m)



Aerosol release
mountain
950 m
Fig. 19
KM
5
4
3
2
1
0
M = 1: 25 000
07.07.1975
Counted aerosol particles
Oberau
Farchant
Garmisch - P.
D 279
C 870
B 596
A 191
H 362
G 373
F 287
E 243
M 268
L 283
K 291
J 248
I 245
R 269
Q 239
P 225
O 208
N 206
T 260
S 238
N

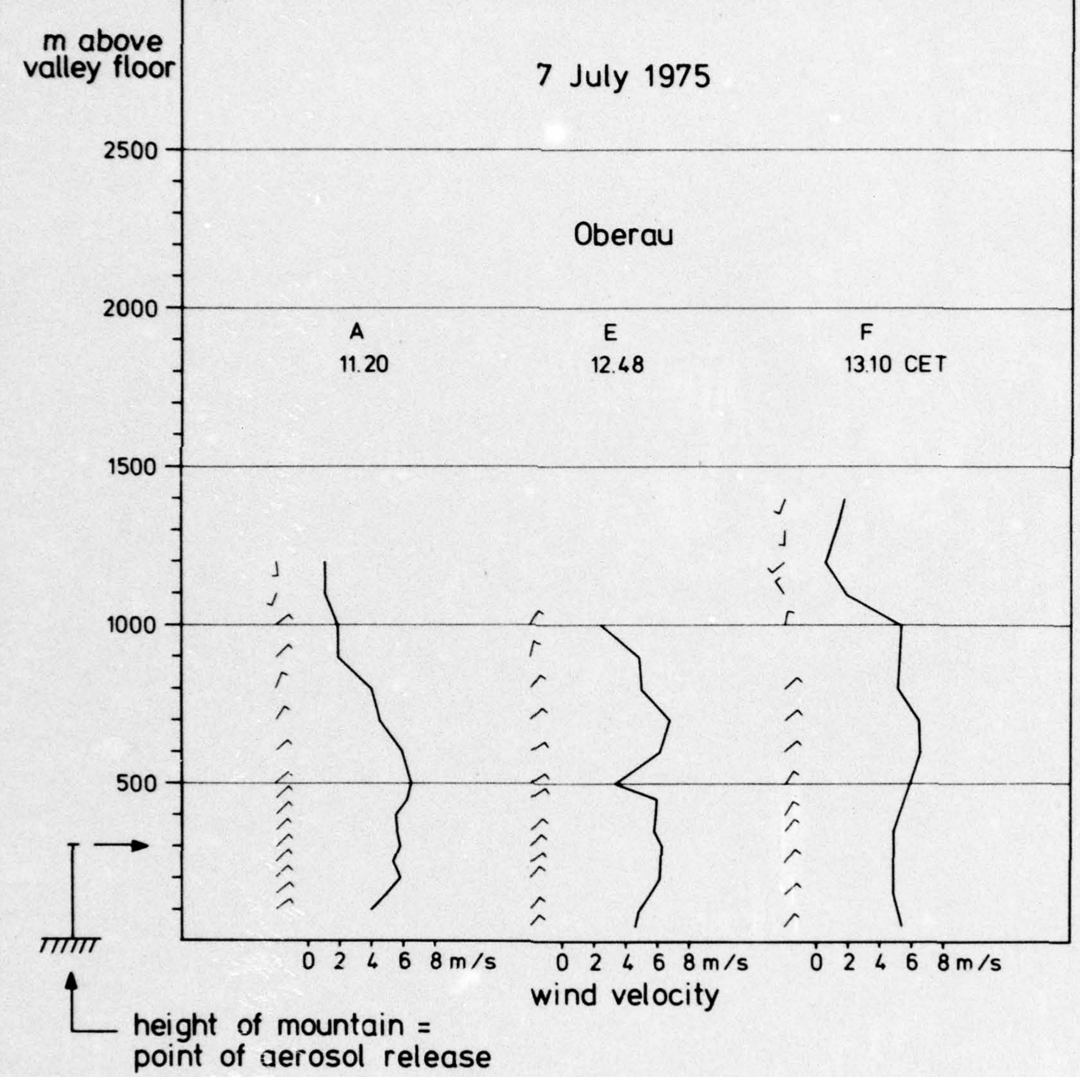
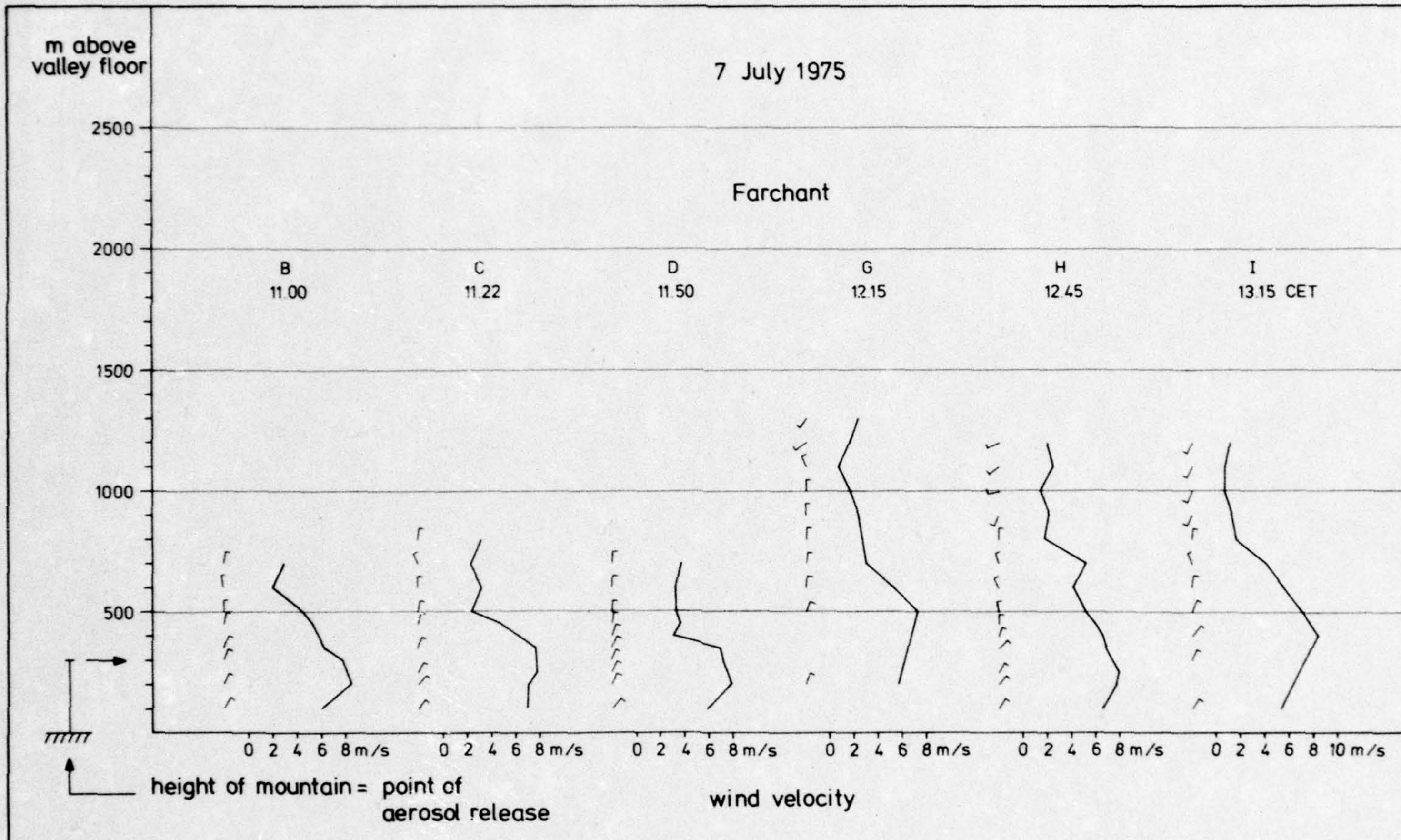

m above valley floor
7 July 1975
Oberau
2500
2000
1500
1000
500
A
11.20
E
12.48
F
13.10 CET
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
wind velocity
height of mountain =
point of aerosol release

Fig. 20

Fig. 21



m above valley floor
7 July 1975
Farchant
2500
2000
1500
1000
500
B 11.00
C 11.22
D 11.50
G 12.15
H 12.45
I 13.15 CET
0 2 4 6 8 m/s
0 2 4 6 8 10 m/s
height of mountain = point of aerosol release
wind velocity

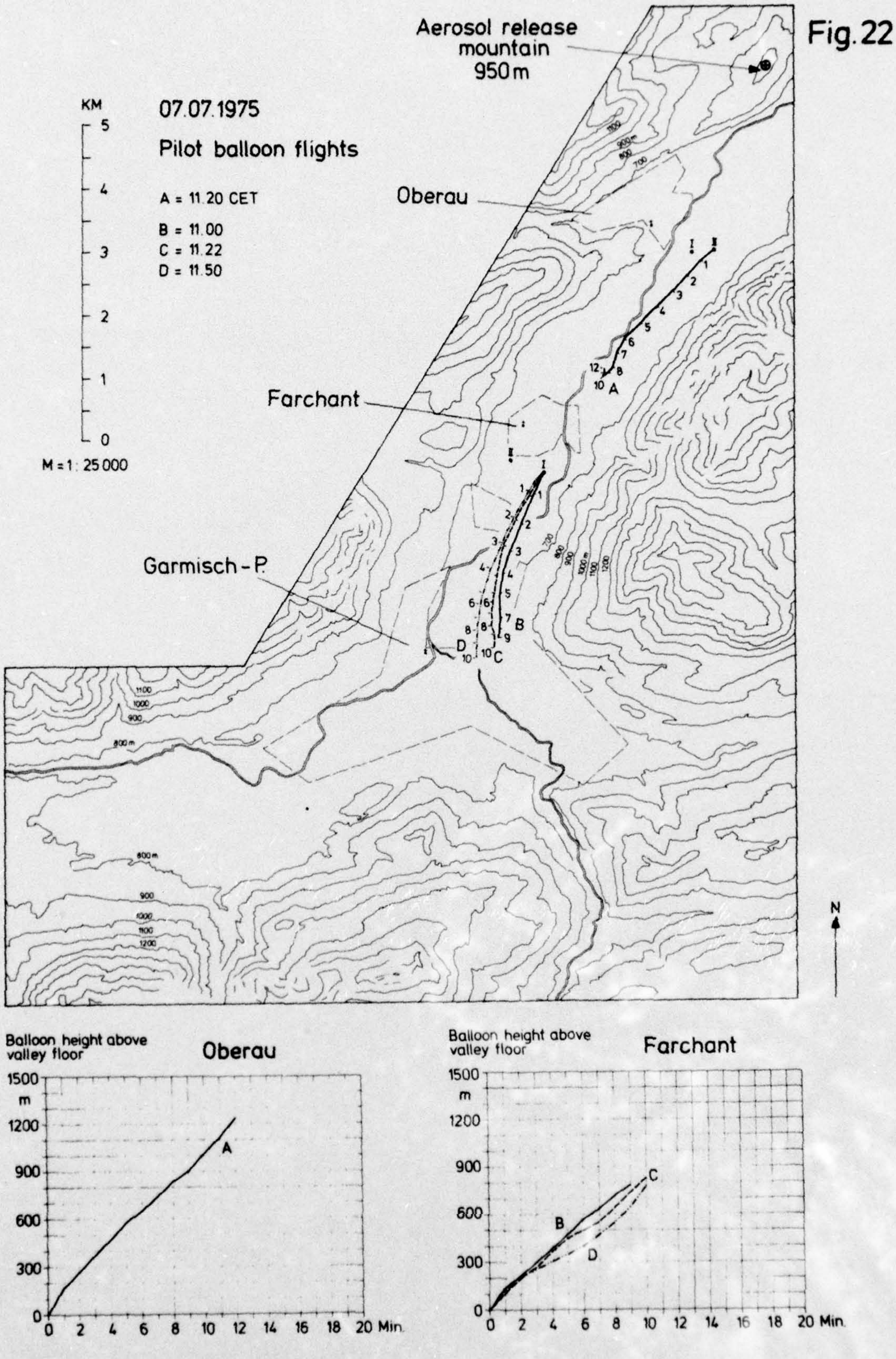


Fig.22
Aerosol release mountain 950m
07.07.1975
Pilot balloon flights
A = 11.20 CET
B = 11.00
C = 11.22
D = 11.50
KM
M = 1: 25000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Oberau
Farchant
m
Min.

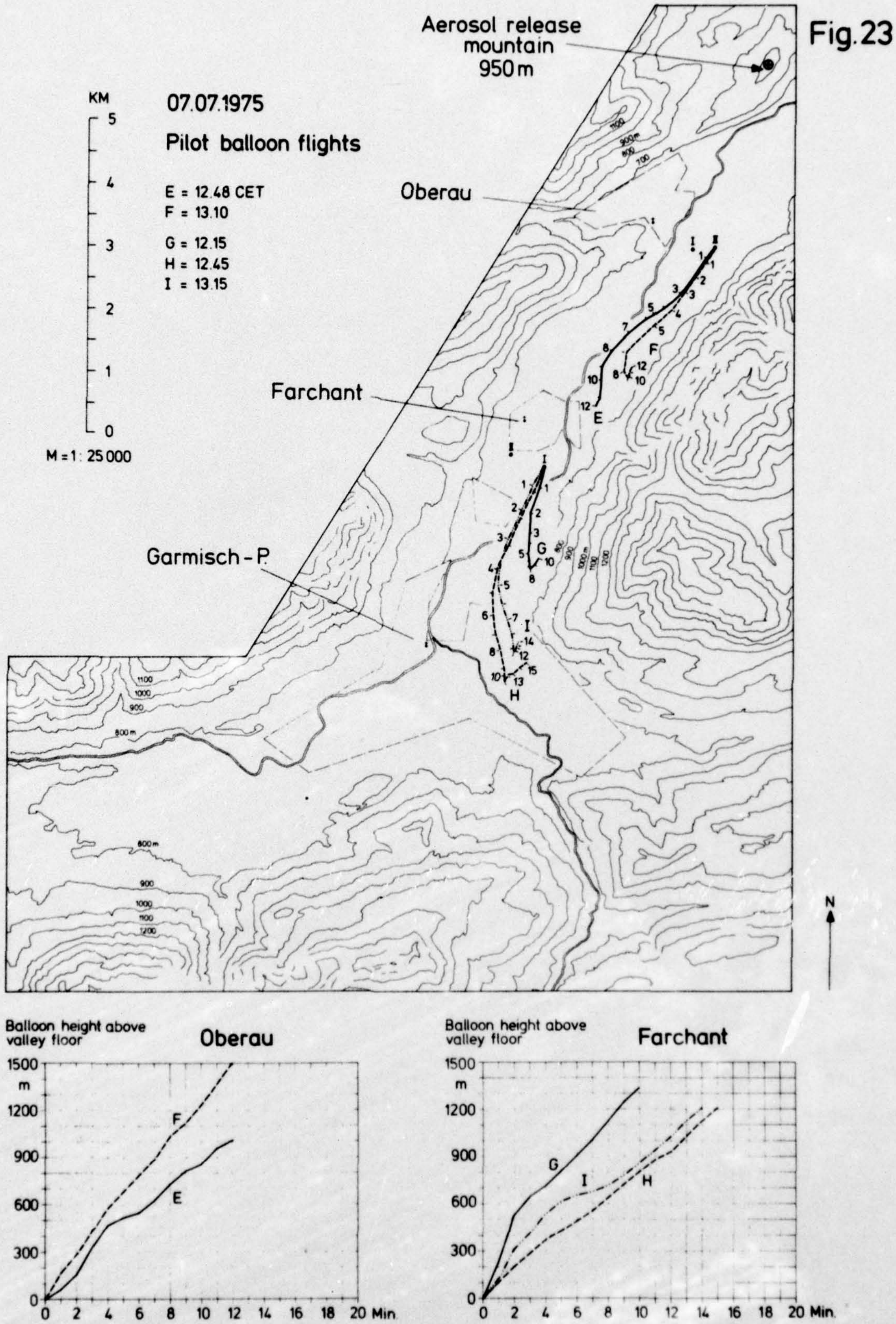

Aerosol release
mountain
950 m
Fig.23
KM
5
4
3
2
1
0
M = 1: 25 000
07.07.1975
Pilot balloon flights
E = 12.48 CET
F = 13.10
G = 12.15
H = 12.45
I = 13.15
Oberau
Farchant
Garmisch - P.
N
Balloon height above valley floor
Oberau
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.
Balloon height above valley floor
Farchant
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.

Fig. 24

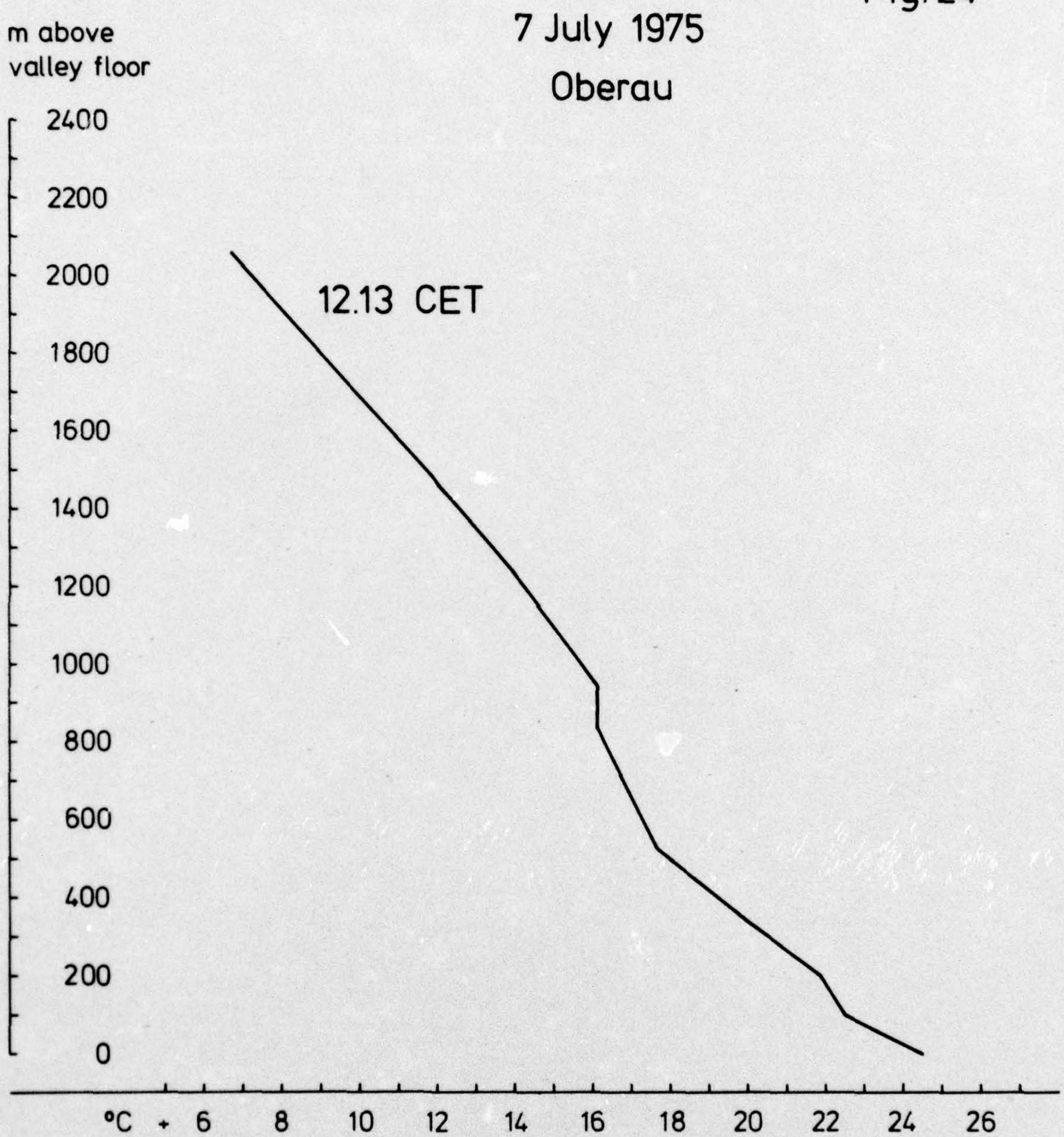
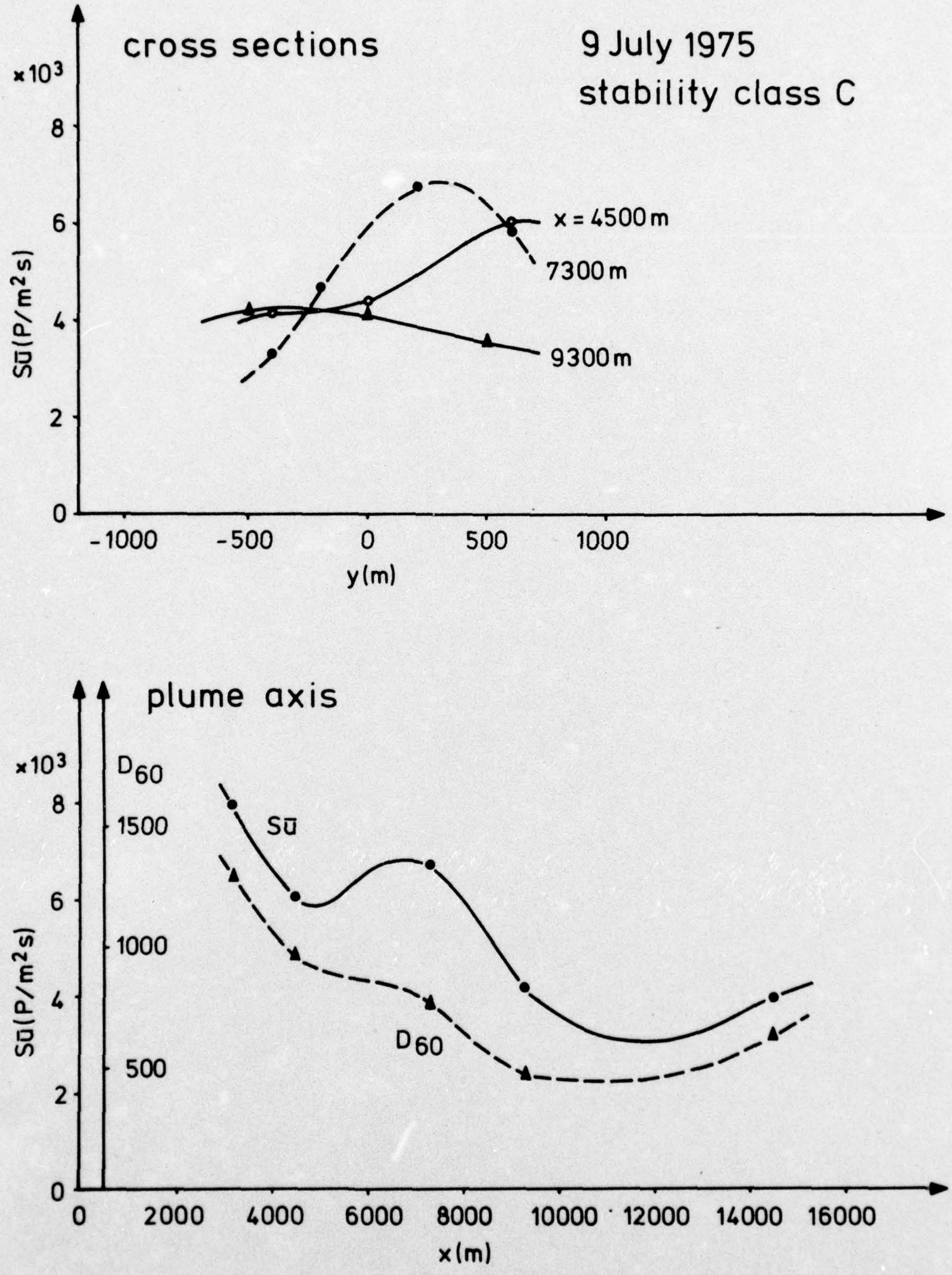
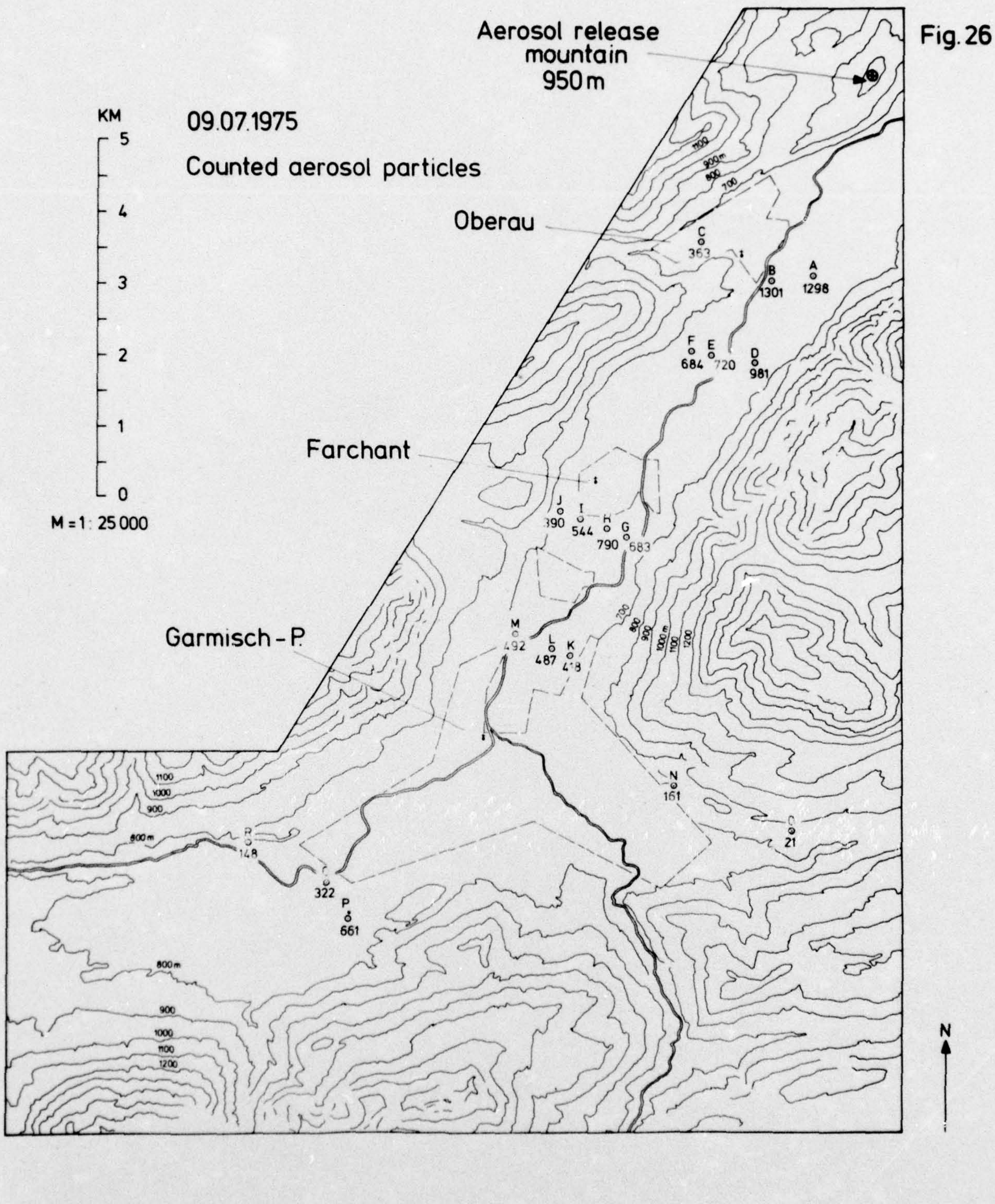

m above
valley floor
7 July 1975
Oberau
12.13 CET
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
°C + 6
8
10
12
14
16
18
20
22
24
26

Fig. 25



cross sections
9 July 1975
stability class C
×10³
8
6
4
2
0
Sū (P/m²s)
x = 4500 m
7300 m
9300 m
-1000
-500
0
500
1000
y (m)
plume axis
×10³
D60
8
6
4
2
0
1500
1000
500
Sū
D60
Sū (P/m²s)
0
2000
4000
6000
8000
10000
12000
14000
16000
x (m)



Aerosol release mountain 950 m
Fig. 26
KM
5
4
3
2
1
0
M = 1: 25 000
09.07.1975
Counted aerosol particles
Oberau
Farchant
Garmisch - P.
C 363
B 1301
A 1298
F 684
E 720
D 981
J 390
I 544
H 790
G 683
M 492
L 487
K 418
N 161
O 21
R 148
Q 322
P 661
1100
1000
900
800 m
900 m
700
1000 m
1200
N

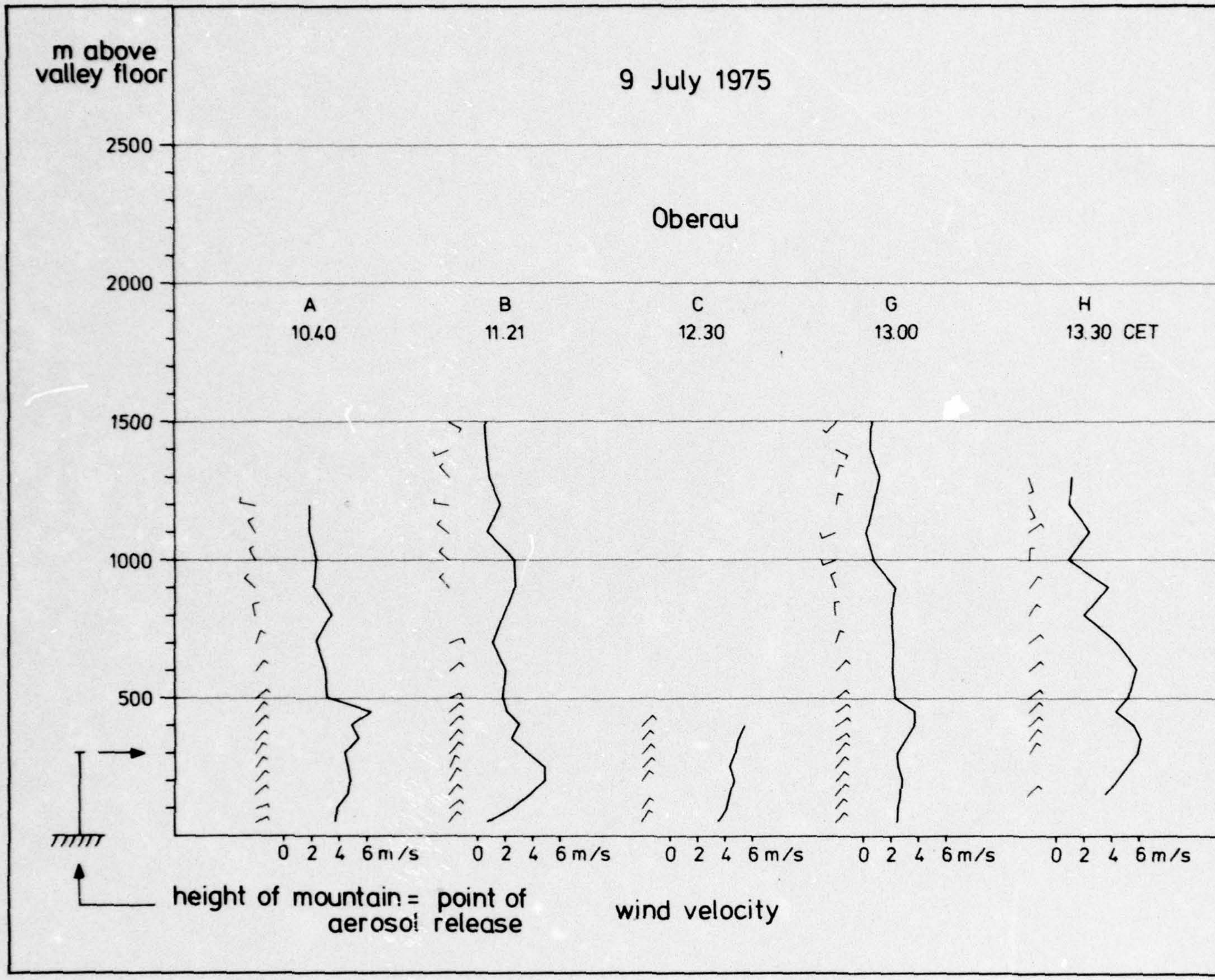
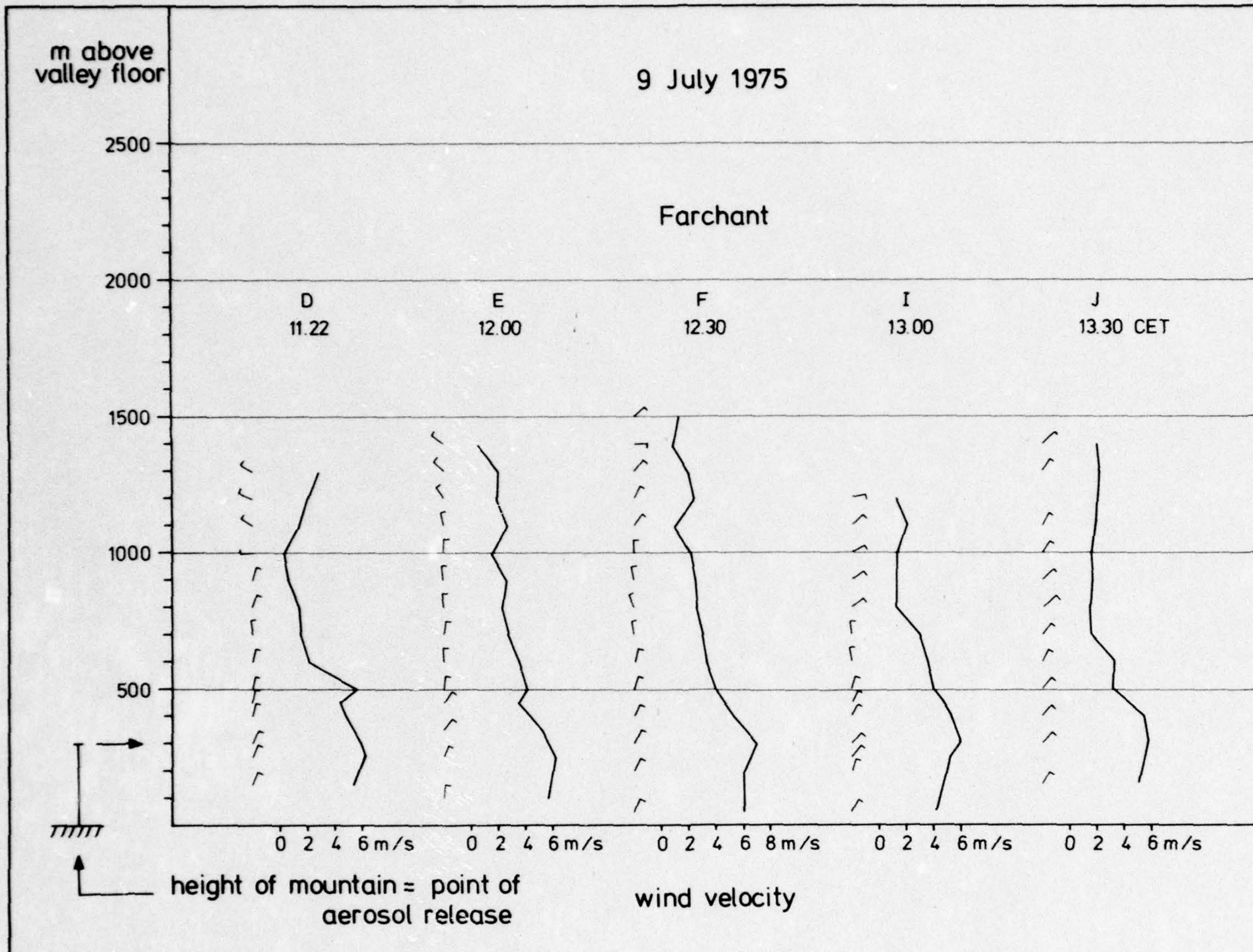

m above valley floor
9 July 1975
Oberau
2500
2000
1500
1000
500
A
10.40
B
11.21
C
12.30
G
13.00
H
13.30 CET
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
height of mountain = point of aerosol release
wind velocity

Fig. 27



m above valley floor
2500
2000
1500
1000
500
9 July 1975
Farchant
D 11.22
E 12.00
F 12.30
I 13.00
J 13.30 CET
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 m/s
0 2 4 6 m/s
height of mountain = point of aerosol release
wind velocity

Fig. 28

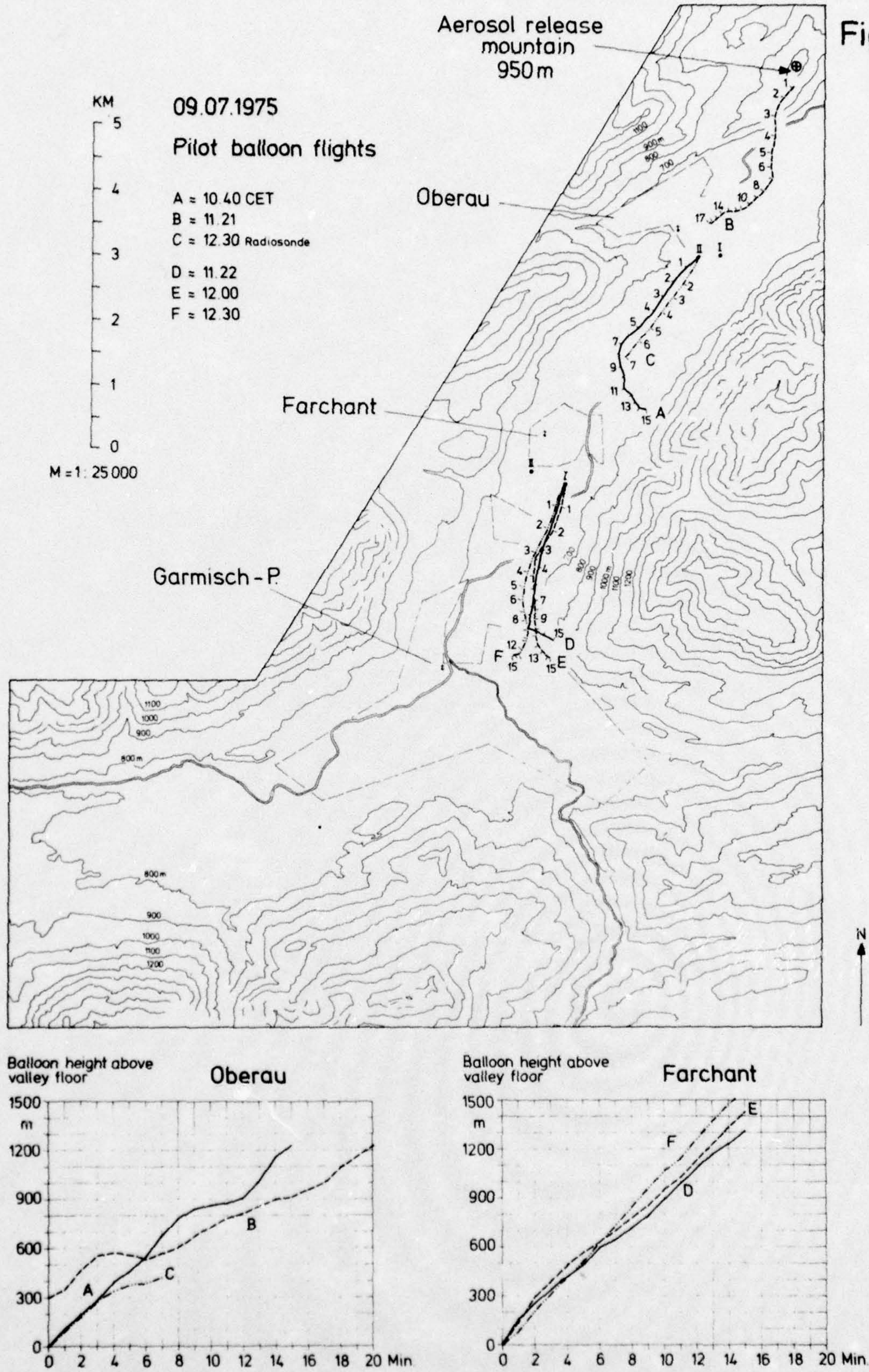
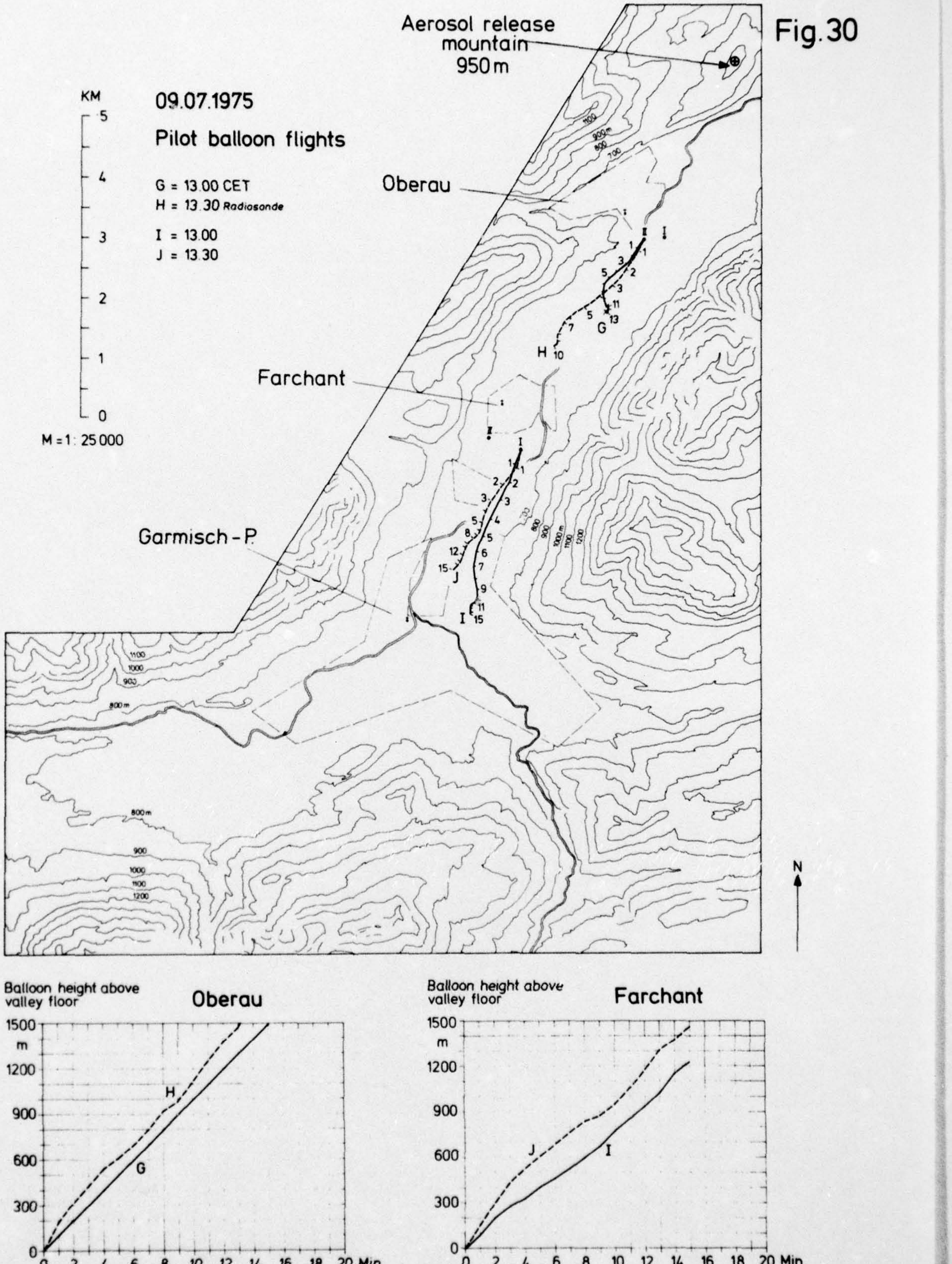

09.07.1975
Pilot balloon flights
A = 10.40 CET
B = 11.21
C = 12.30 Radiosonde
D = 11.22
E = 12.00
F = 12.30
KM
M = 1: 25 000
Aerosol release mountain 950 m
Oberau
Farchant
Garmisch - P.
N
Balloon height above valley floor
Oberau
Balloon height above valley floor
Farchant
Min.

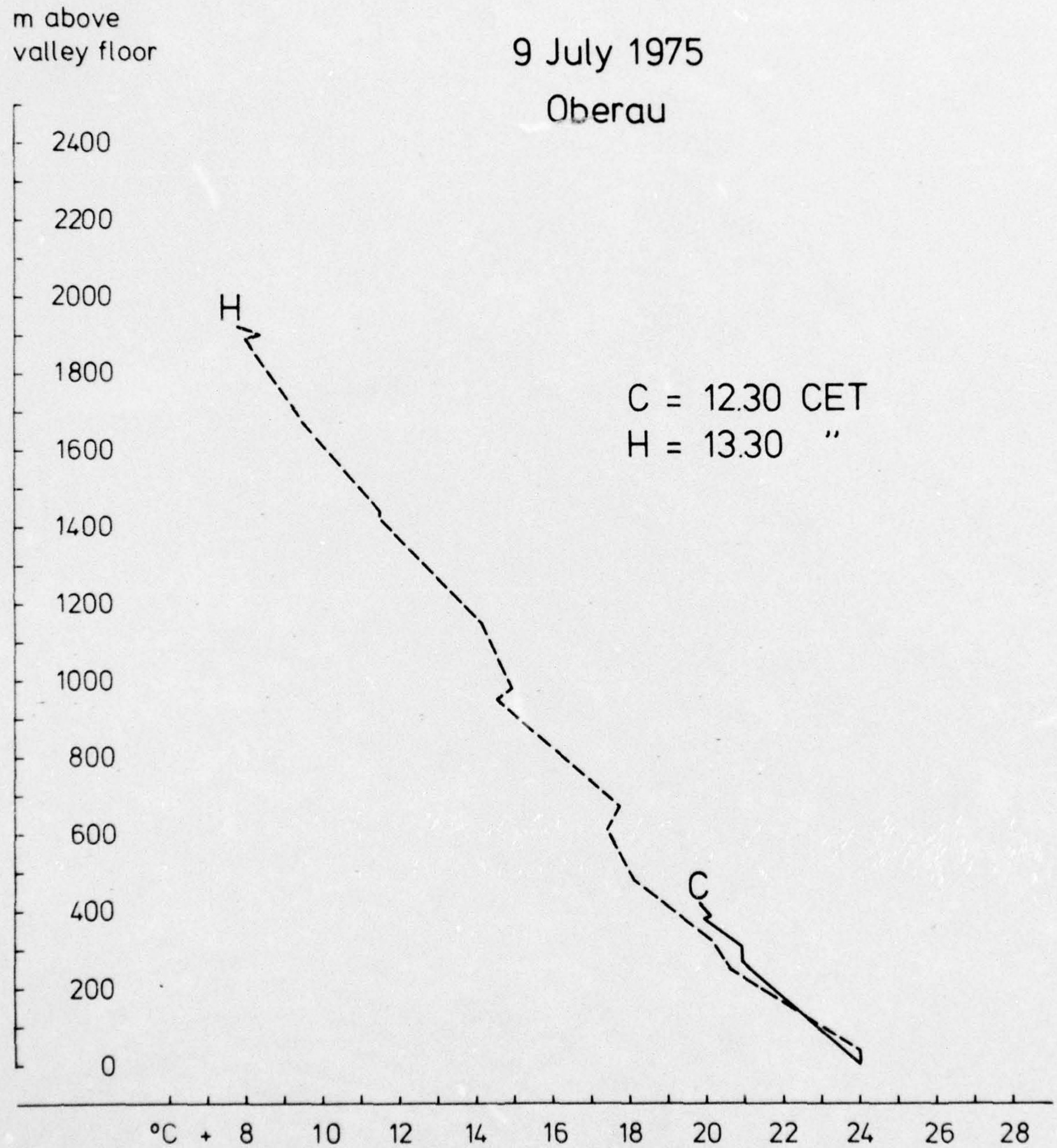
Fig. 29

Fig. 30



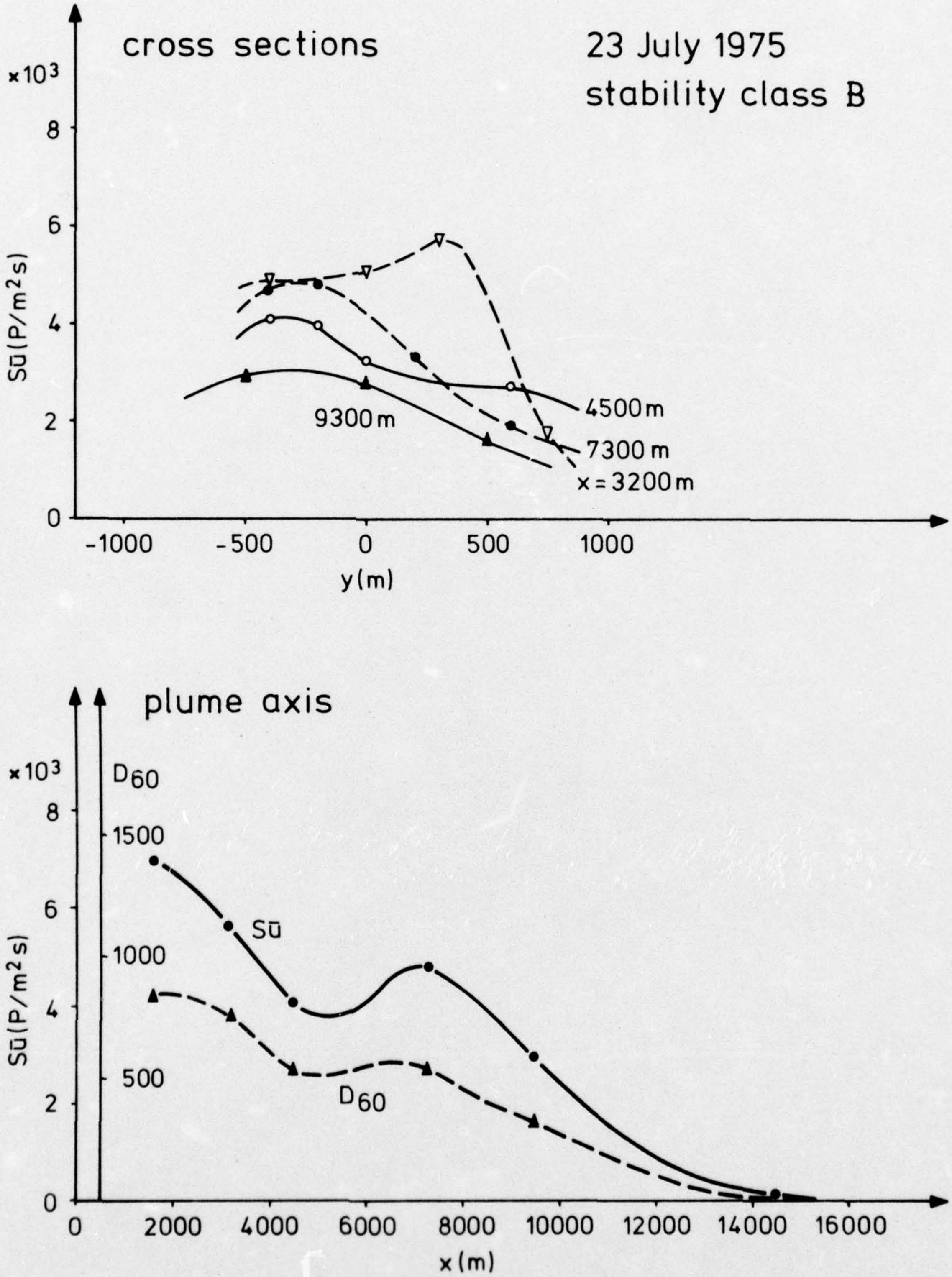
Aerosol release mountain 950 m
09.07.1975
Pilot balloon flights
G = 13.00 CET
H = 13.30 Radiosonde
I = 13.00
J = 13.30
KM
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Oberau
Farchant
m
Min.

Fig. 31



m above
valley floor
9 July 1975
Oberau
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
H
C
C = 12.30 CET
H = 13.30 "
°C + 8
10
12
14
16
18
20
22
24
26
28

Fig. 32



cross sections
23 July 1975
stability class B
×10³
8
6
4
2
0
Sū (P/m² s)
4500 m
9300 m
7300 m
x = 3200 m
-1000
-500
0
500
1000
y (m)
plume axis
×10³
D60
8
1500
6
Sū
1000
4
500
2
D60
0
Sū (P/m² s)
0
2000
4000
6000
8000
10000
12000
14000
16000
x (m)

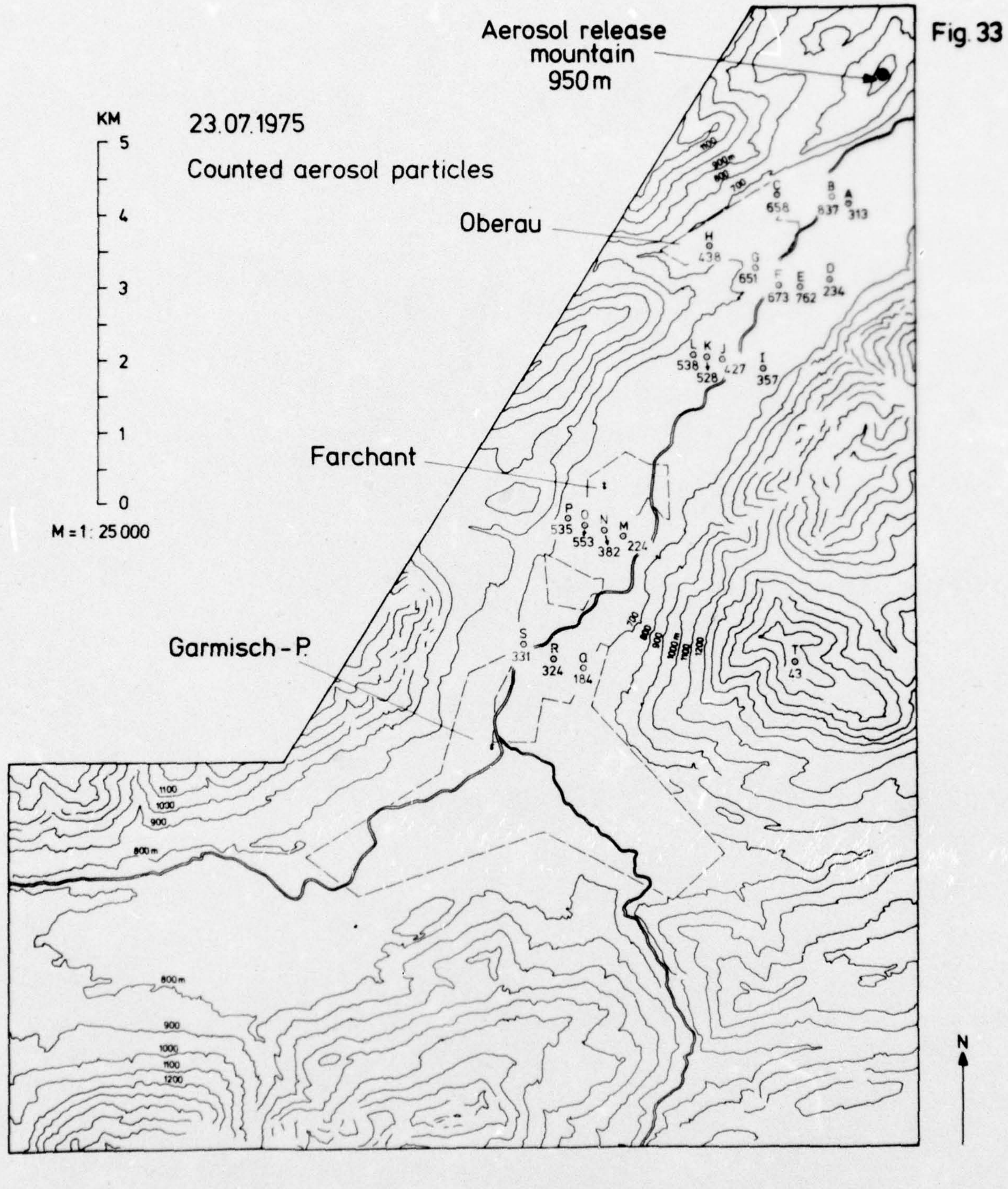
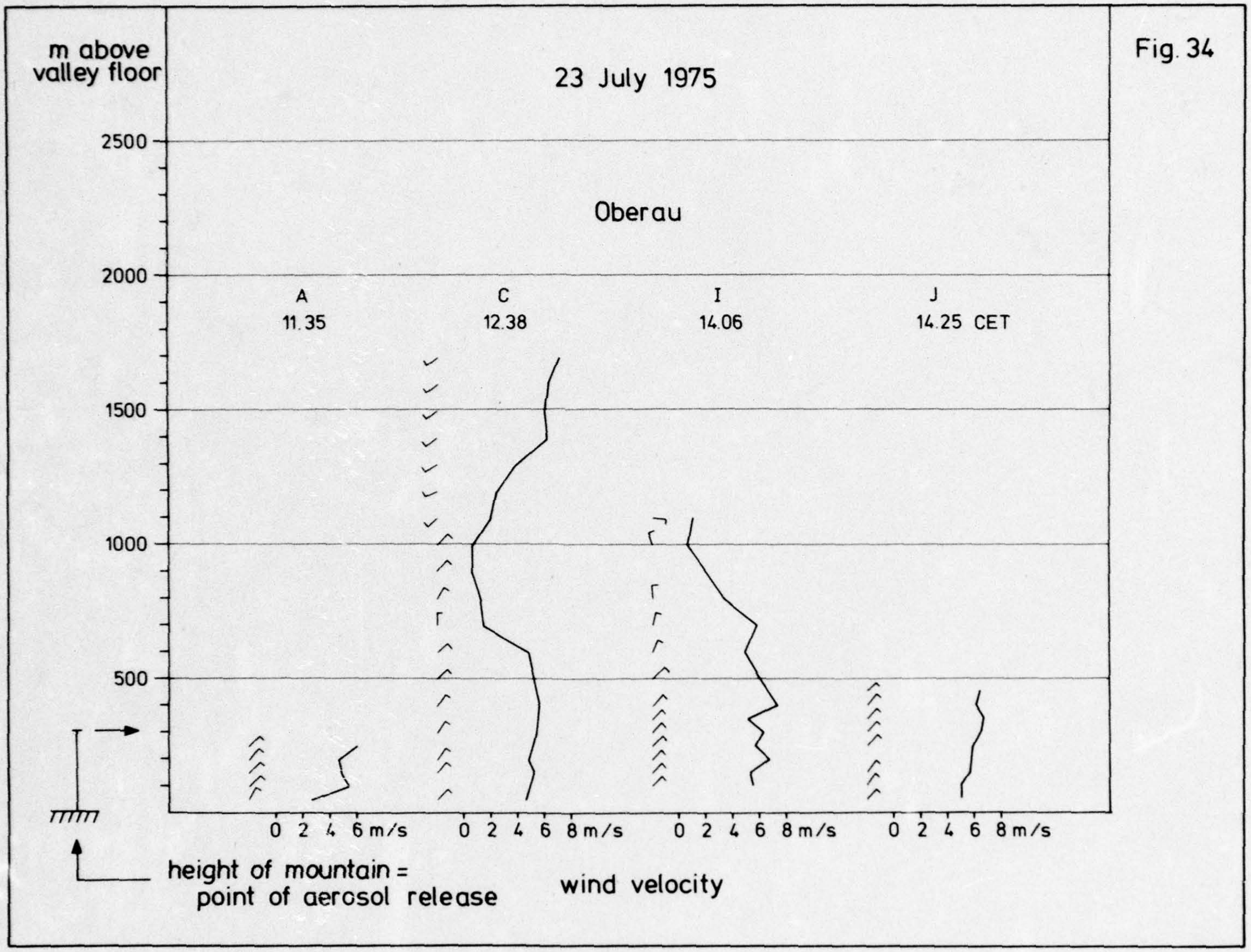
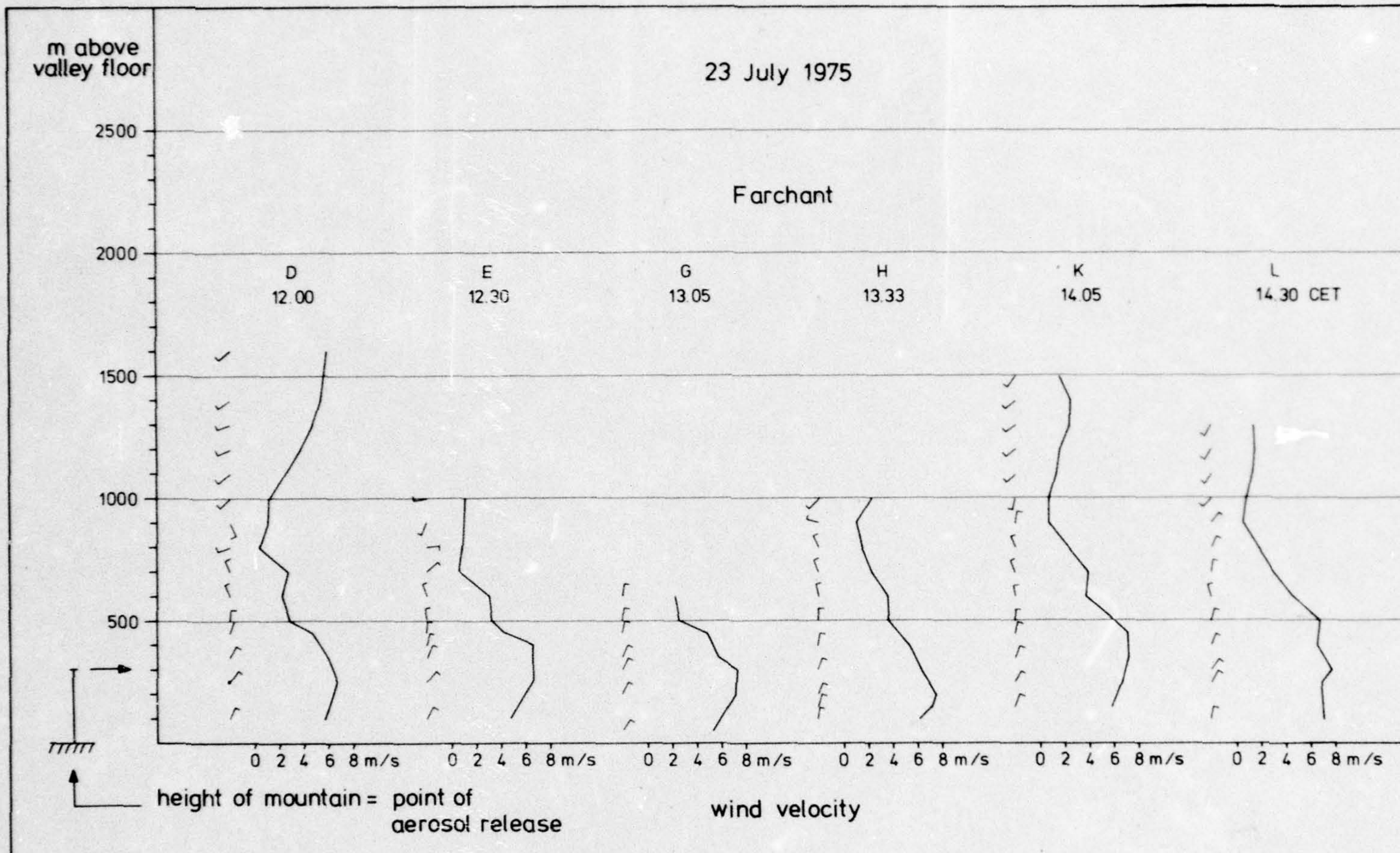

Aerosol release
mountain
950m
Fig. 33
KM
5
4
3
2
1
0
M = 1: 25 000
23.07.1975
Counted aerosol particles
Oberau
Farchant
Garmisch-P.
C
658
B
837
A
313
H
438
G
651
F
673
E
762
D
234
L
538
K
528
J
427
I
357
P
535
O
553
N
382
M
224
S
331
R
324
Q
184
T
43
N

Fig. 34

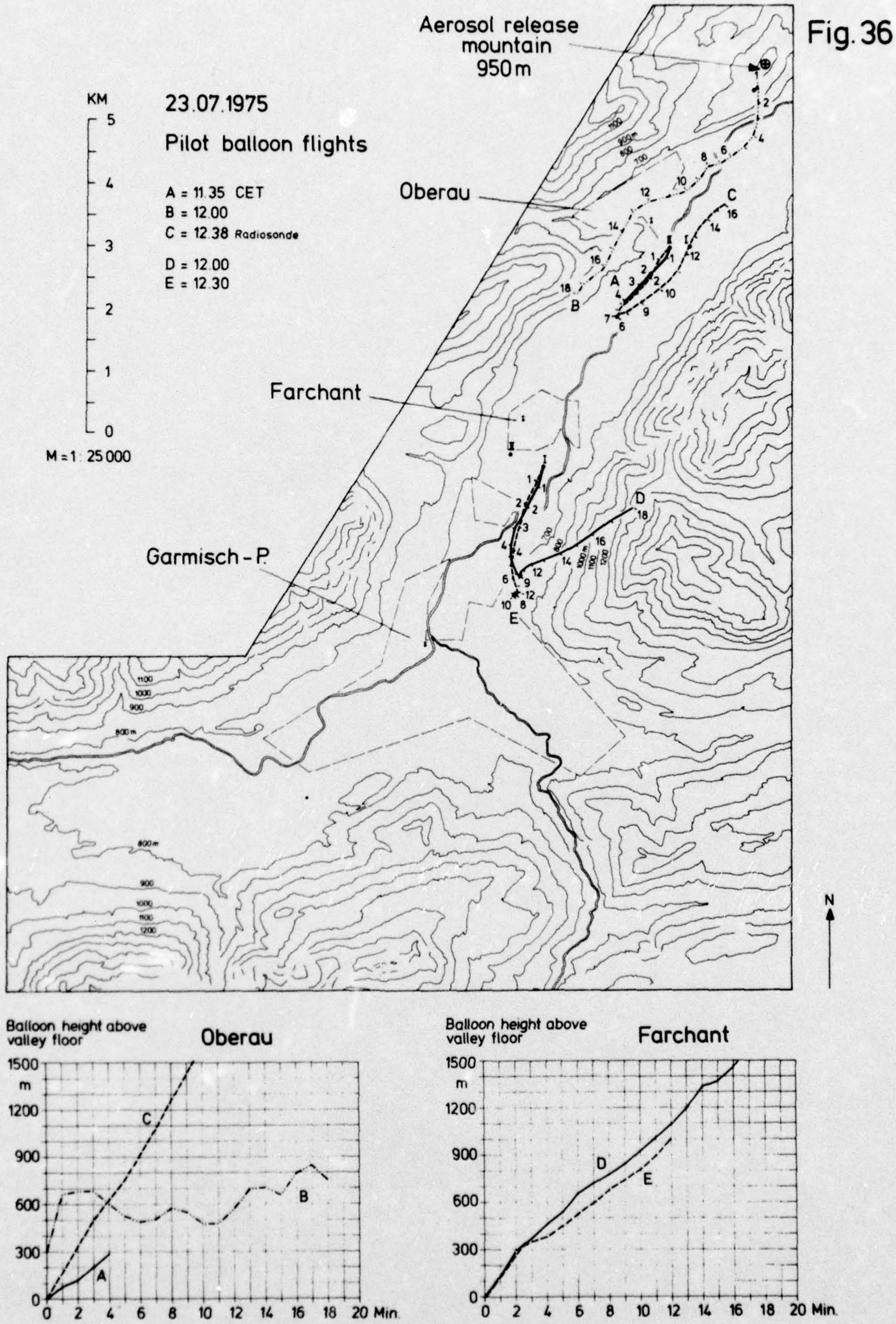

m above
valley floor
23 July 1975
Oberau
2500
2000
1500
1000
500
A
11.35
C
12.38
I
14.06
J
14.25 CET
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
height of mountain =
point of aerosol release
wind velocity



m above
valley floor
23 July 1975
Farchant
2500
2000
1500
1000
500
D
12.00
E
12.30
G
13.05
H
13.33
K
14.05
L
14.30 CET
0 2 4 6 8 m/s
height of mountain = point of
aerosol release
wind velocity

Fig. 35

Fig. 36


Aerosol release
mountain
950 m
KM
5
4
3
2
1
0
M = 1: 25 000
23.07.1975
Pilot balloon flights
A = 11.35 CET
B = 12.00
C = 12.38 Radiosonde
D = 12.00
E = 12.30
Oberau
Farchant
Garmisch - P.
N
Balloon height above
valley floor
Oberau
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.
Balloon height above
valley floor
Farchant
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.

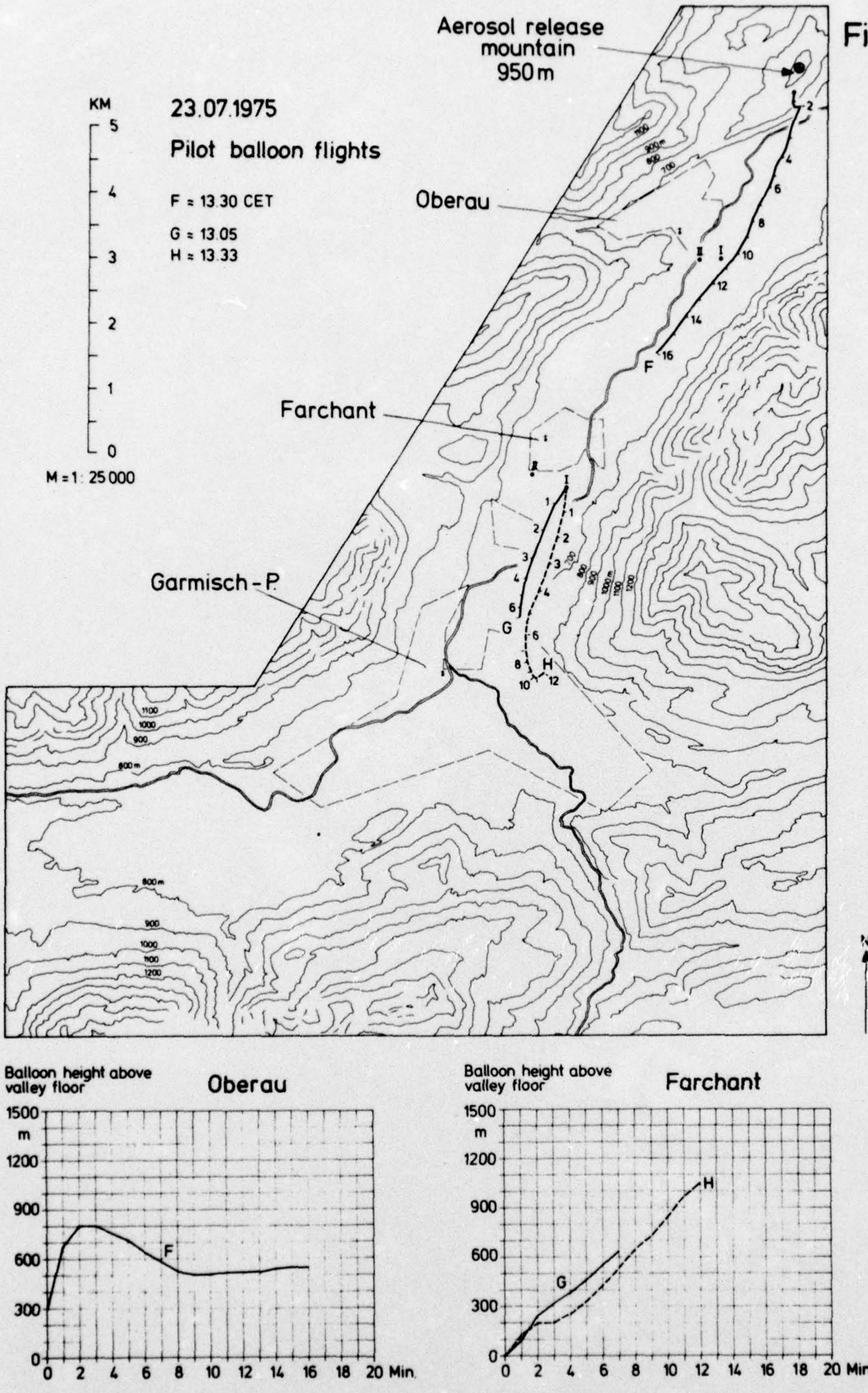

Aerosol release
mountain
950 m
23.07.1975
Pilot balloon flights
F = 13.30 CET
G = 13.05
H = 13.33
KM
M = 1: 25000
Oberau
Farchant
Garmisch-P.
Balloon height above valley floor
Oberau
Balloon height above valley floor
Farchant
m
Min.

Fig. 37

Fig. 38

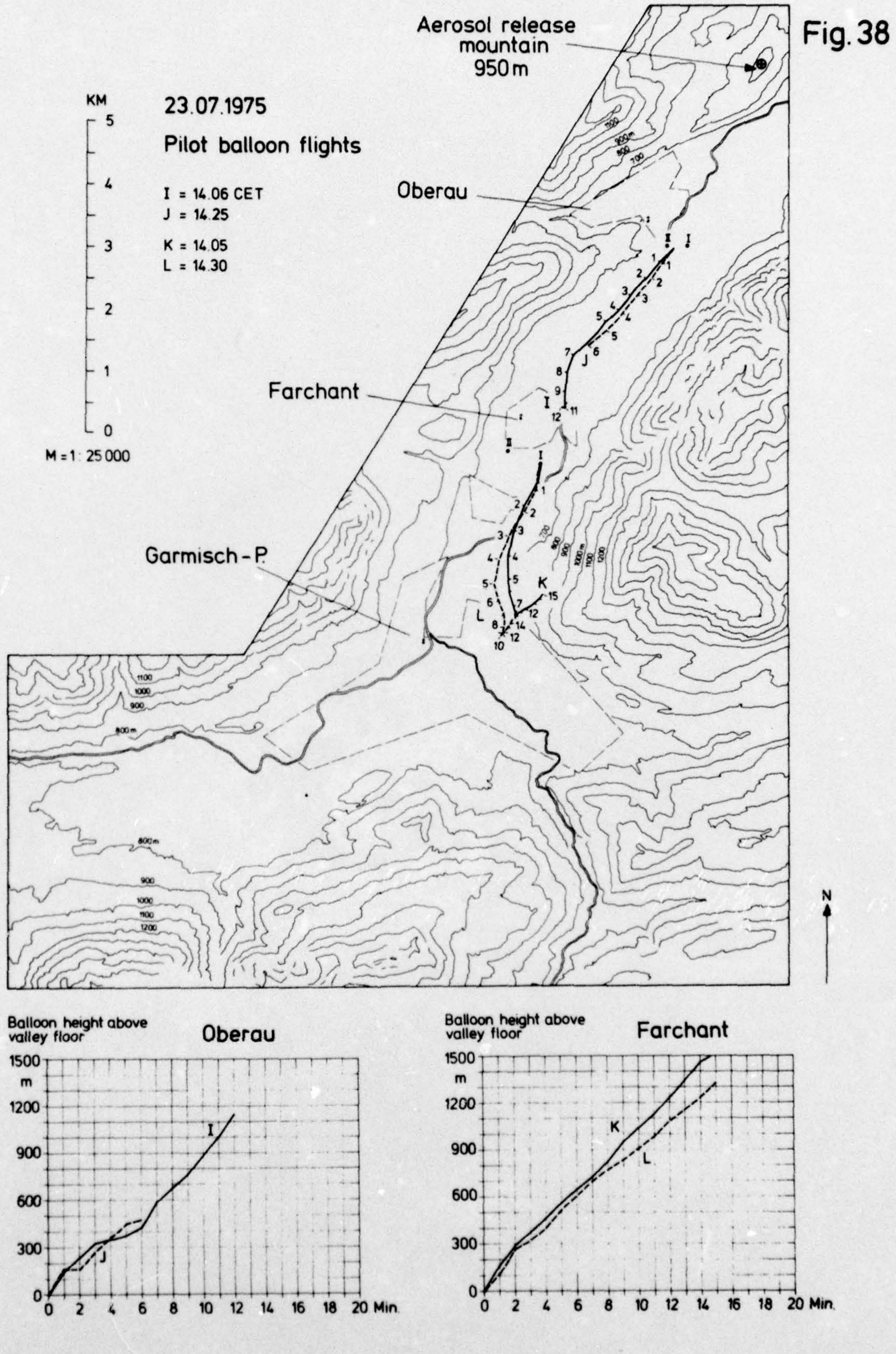

Aerosol release mountain 950 m
23.07.1975
Pilot balloon flights
I = 14.06 CET
J = 14.25
K = 14.05
L = 14.30
KM
M = 1 : 25 000
Oberau
Farchant
Garmisch - P.
N
Balloon height above valley floor
Oberau
Farchant
m
Min.

Fig. 39

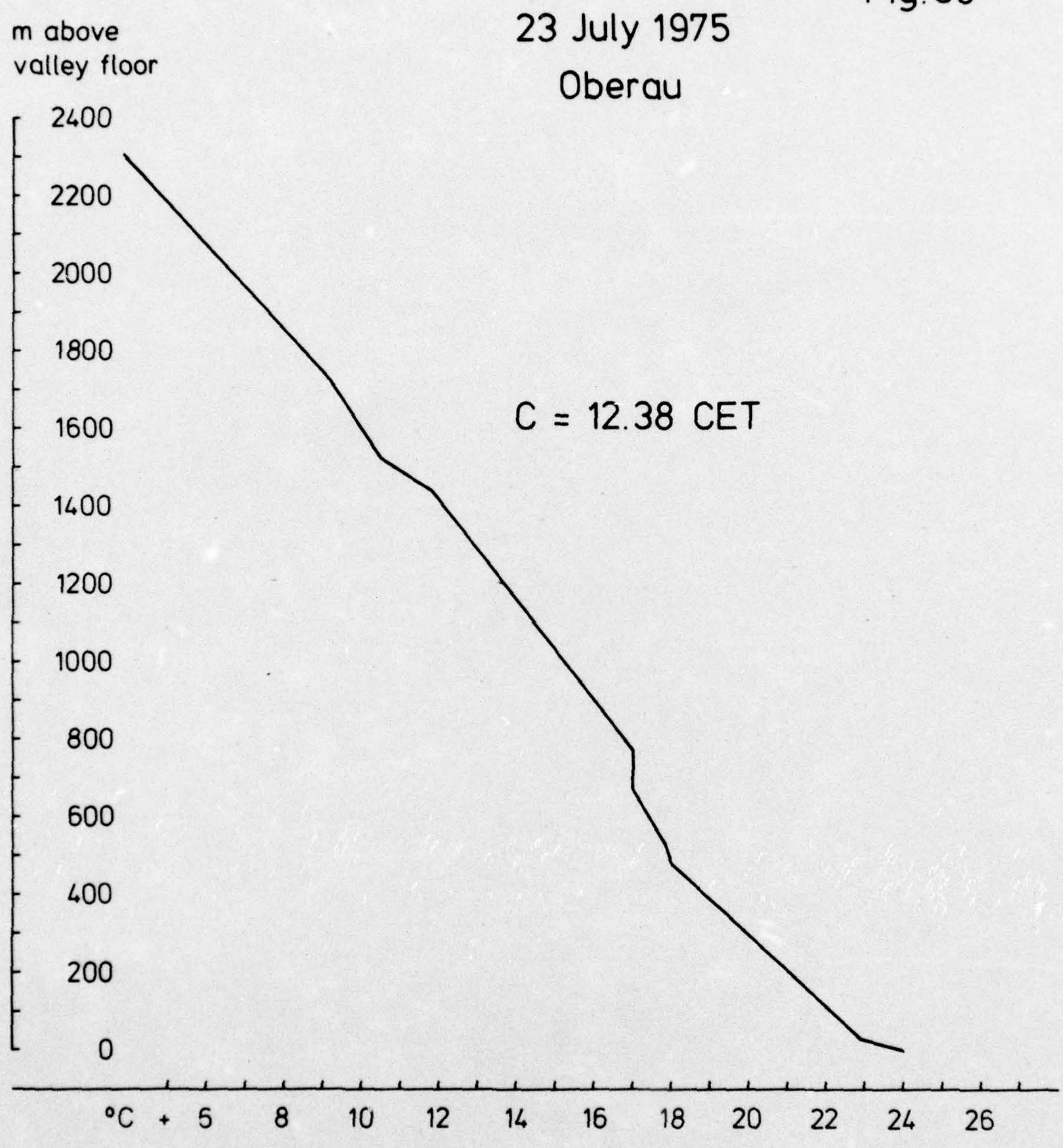
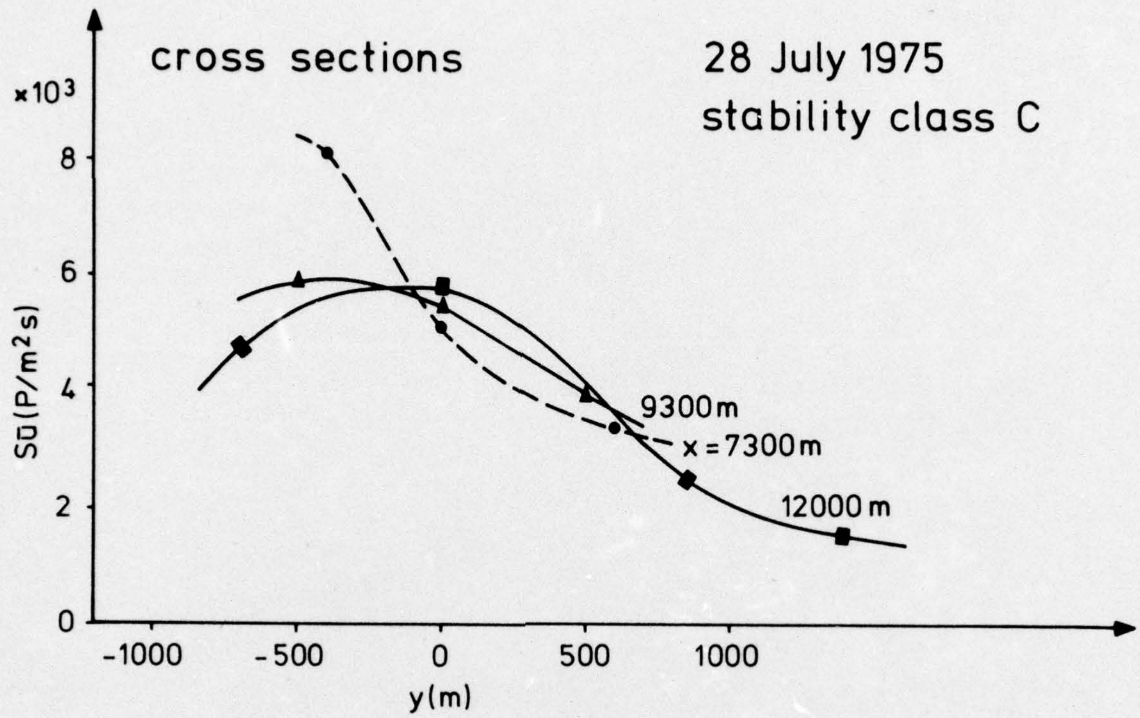
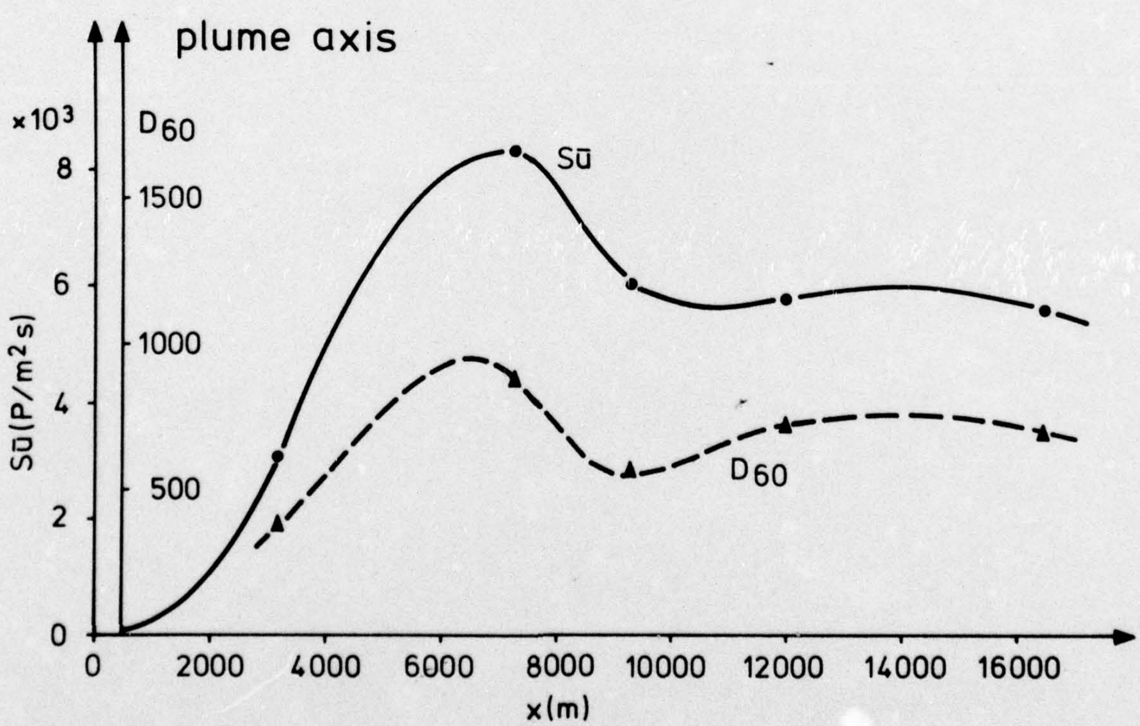

m above
valley floor
23 July 1975
Oberau
C = 12.38 CET
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
°C + 5
8
10
12
14
16
18
20
22
24
26

Fig. 40

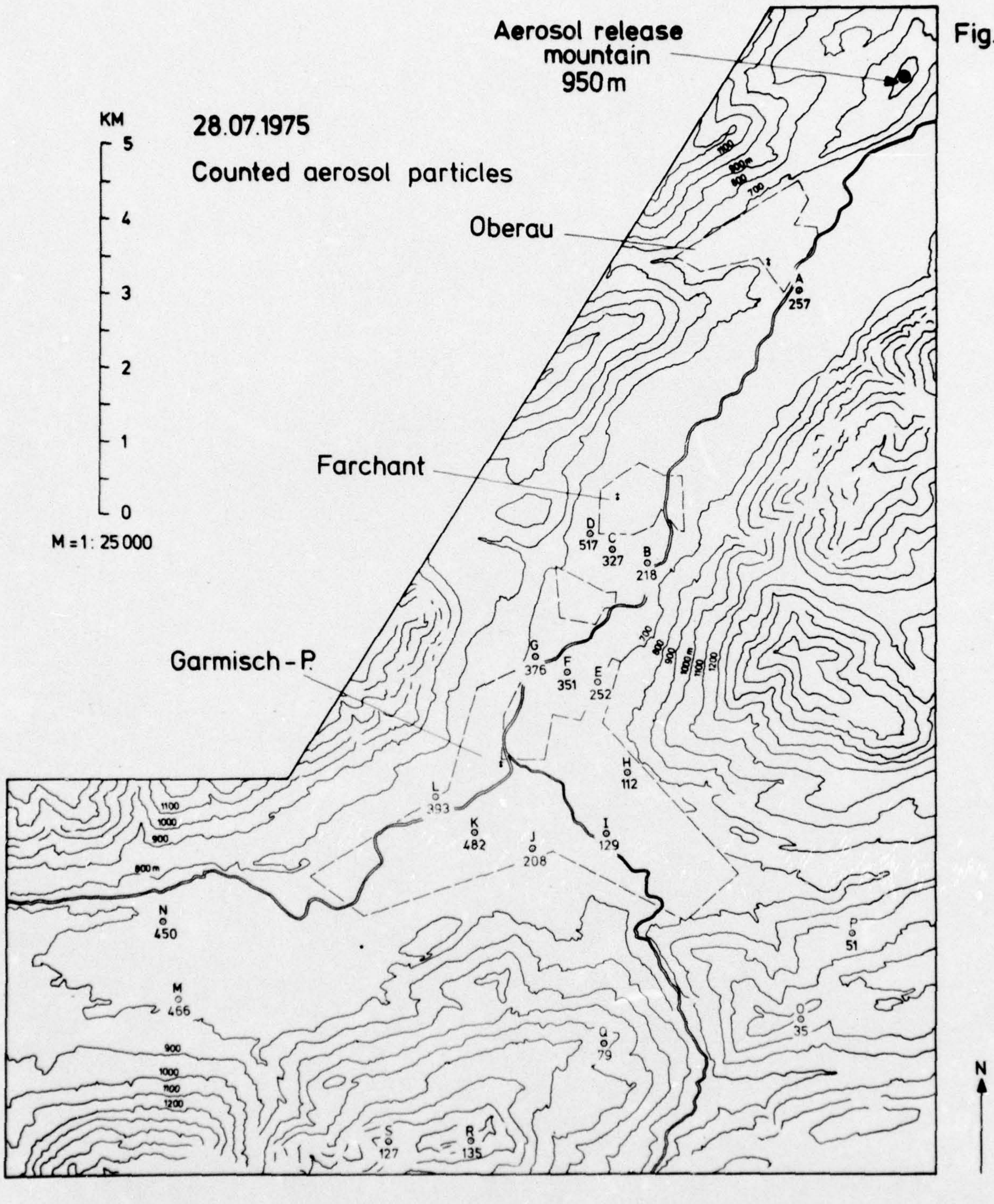


cross sections
28 July 1975
stability class C
x10³
Sū(P/m²s)
8
6
4
2
0
9300m
x=7300m
12000m
-1000
-500
0
500
1000
y(m)



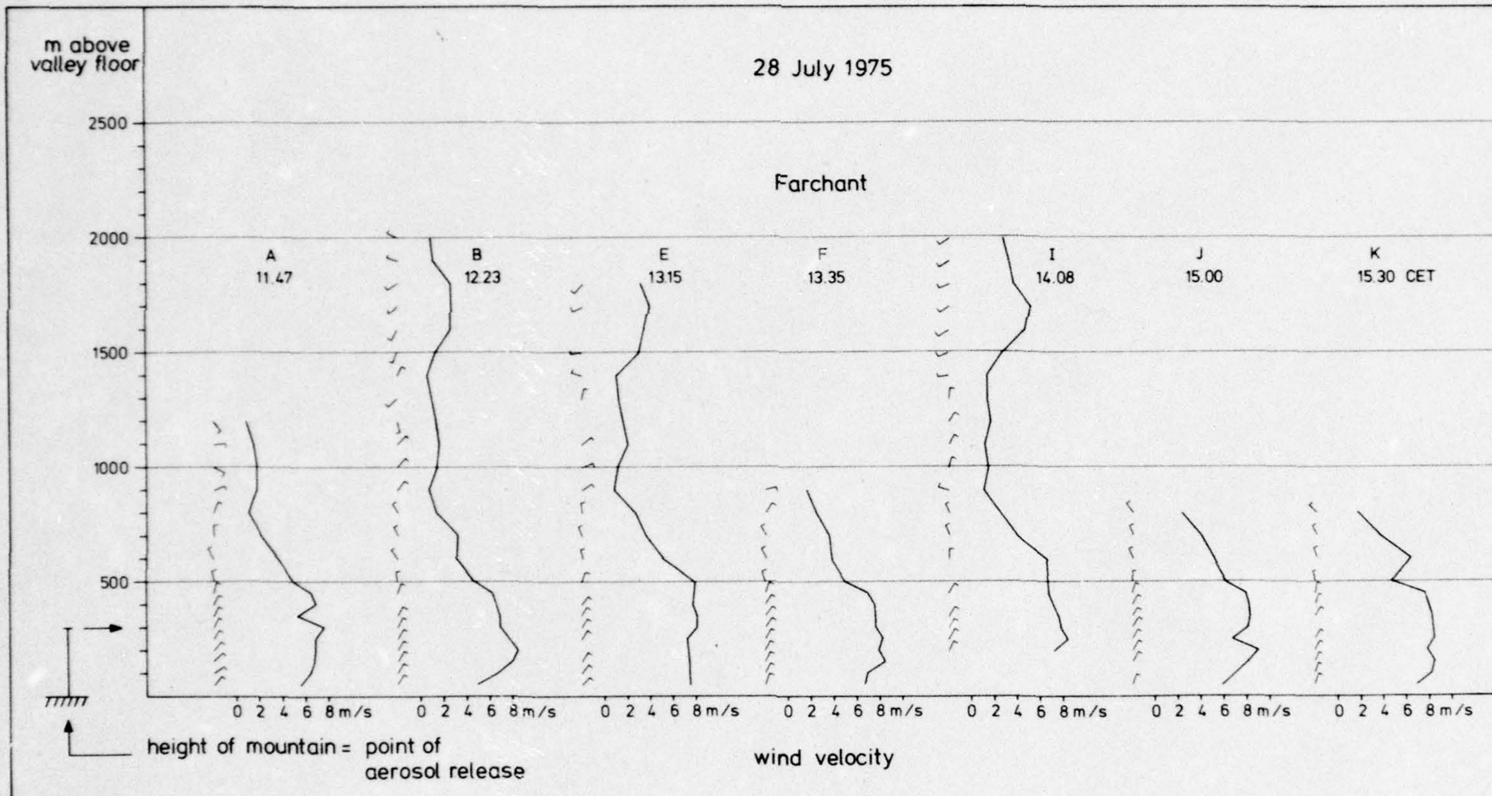
plume axis
x10³
D60
Sū
8
1500
6
1000
4
500
2
0
Sū(P/m²s)
D60
0
2000
4000
6000
8000
10000
12000
14000
16000
x(m)

Fig. 41



28.07.1975
Counted aerosol particles
KM
5
4
3
2
1
0
M = 1: 25 000
Aerosol release
mountain
950 m
Oberau
A
257
Farchant
D
517
C
327
B
218
Garmisch - P.
G
376
F
351
E
252
H
112
L
393
K
482
J
208
I
129
N
450
M
466
P
51
O
35
Q
79
S
127
R
135
N

Fig. 42



28 July 1975
Farchant
m above valley floor
2500
2000
1500
1000
500
A 11.47
B 12.23
E 13.15
F 13.35
I 14.08
J 15.00
K 15.30 CET
0 2 4 6 8m/s
wind velocity
height of mountain = point of aerosol release

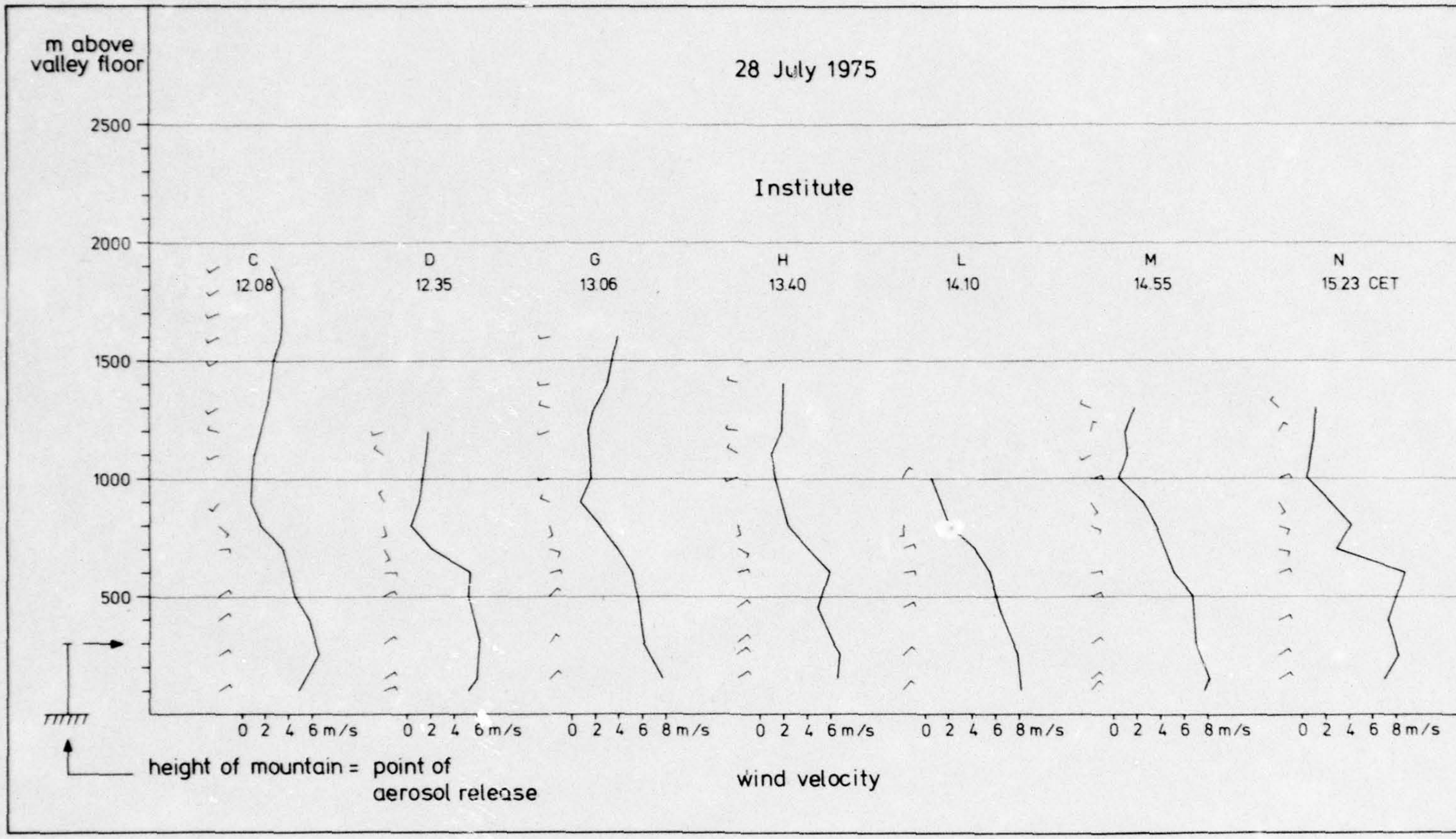
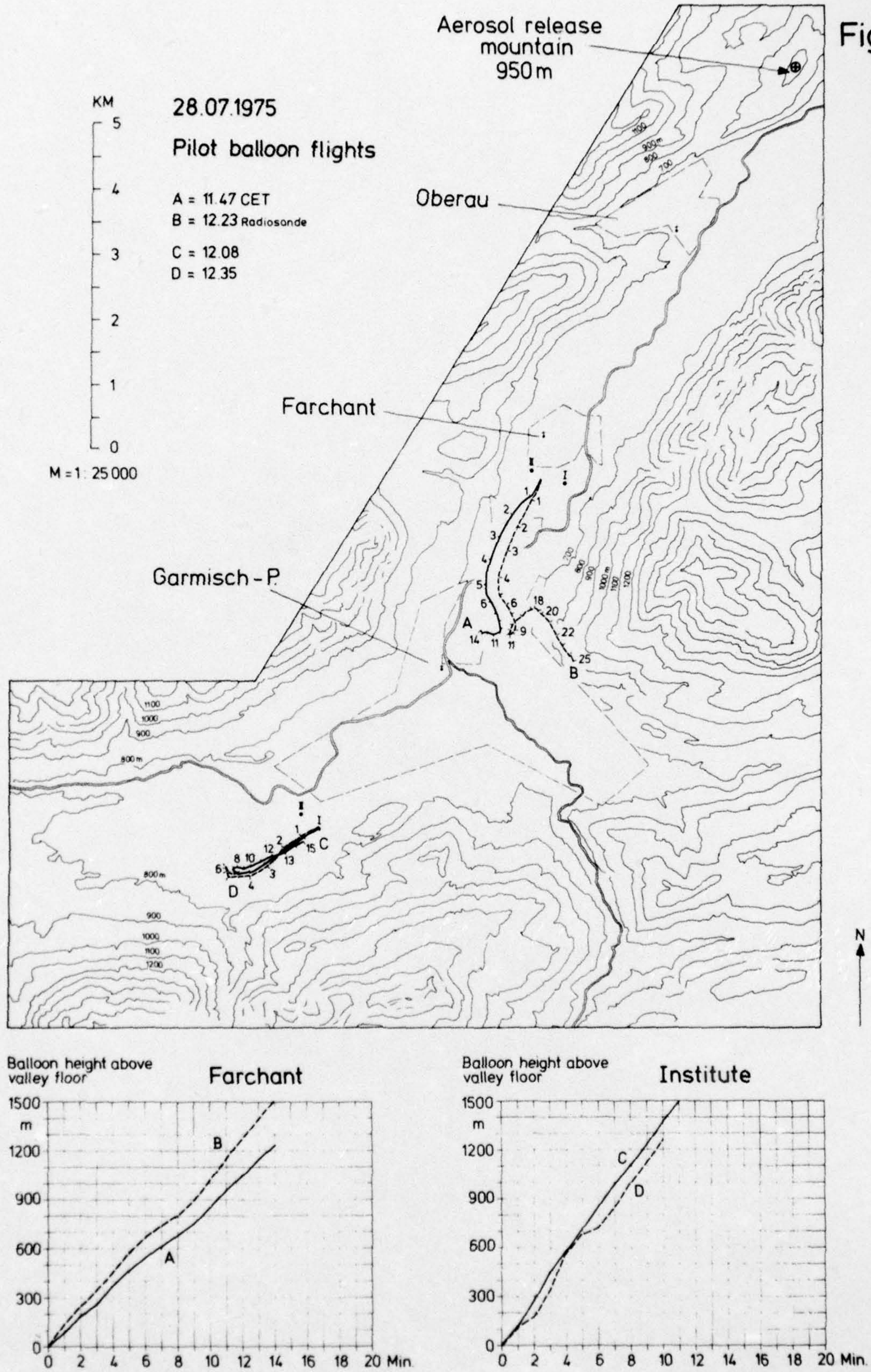

m above valley floor
28 July 1975
2500
Institute
2000
C 12.08
D 12.35
G 13.06
H 13.40
L 14.10
M 14.55
N 15.23 CET
1500
1000
500
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
height of mountain = point of aerosol release
wind velocity

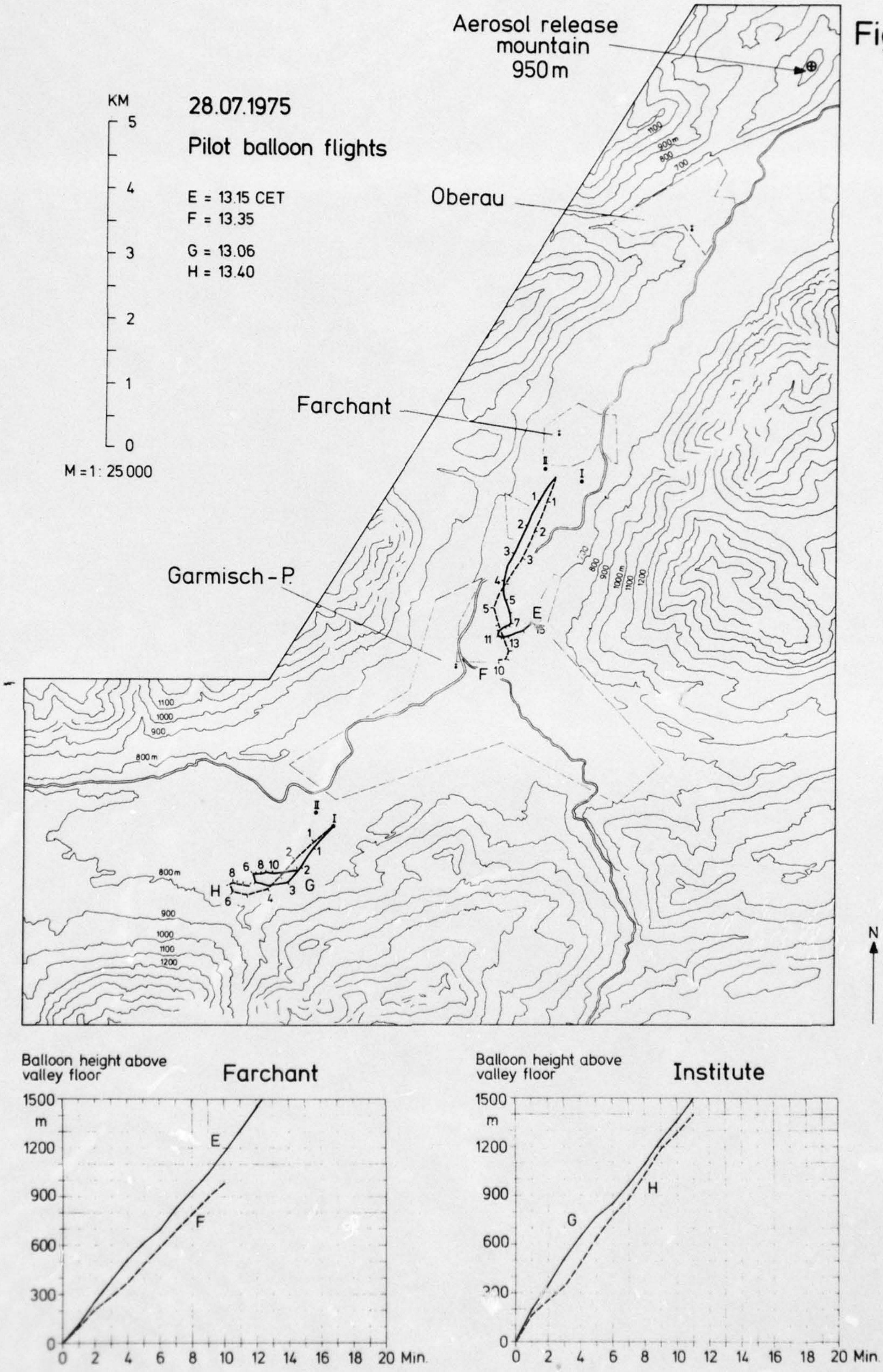
Fig. 43

Fig. 44



Aerosol release mountain 950 m
KM
5
4
3
2
1
0
M = 1: 25 000
28.07.1975
Pilot balloon flights
A = 11.47 CET
B = 12.23 Radiosonde
C = 12.08
D = 12.35
Oberau
Farchant
Garmisch - P.
N
Balloon height above valley floor
Farchant
Institute
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.

Fig.45



Aerosol release mountain 950 m
28.07.1975
Pilot balloon flights
E = 13.15 CET
F = 13.35
G = 13.06
H = 13.40
KM
5
4
3
2
1
0
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
E
F
G
H
N
1100
1000
900
800 m
1200
Balloon height above valley floor
Farchant
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.
Balloon height above valley floor
Institute

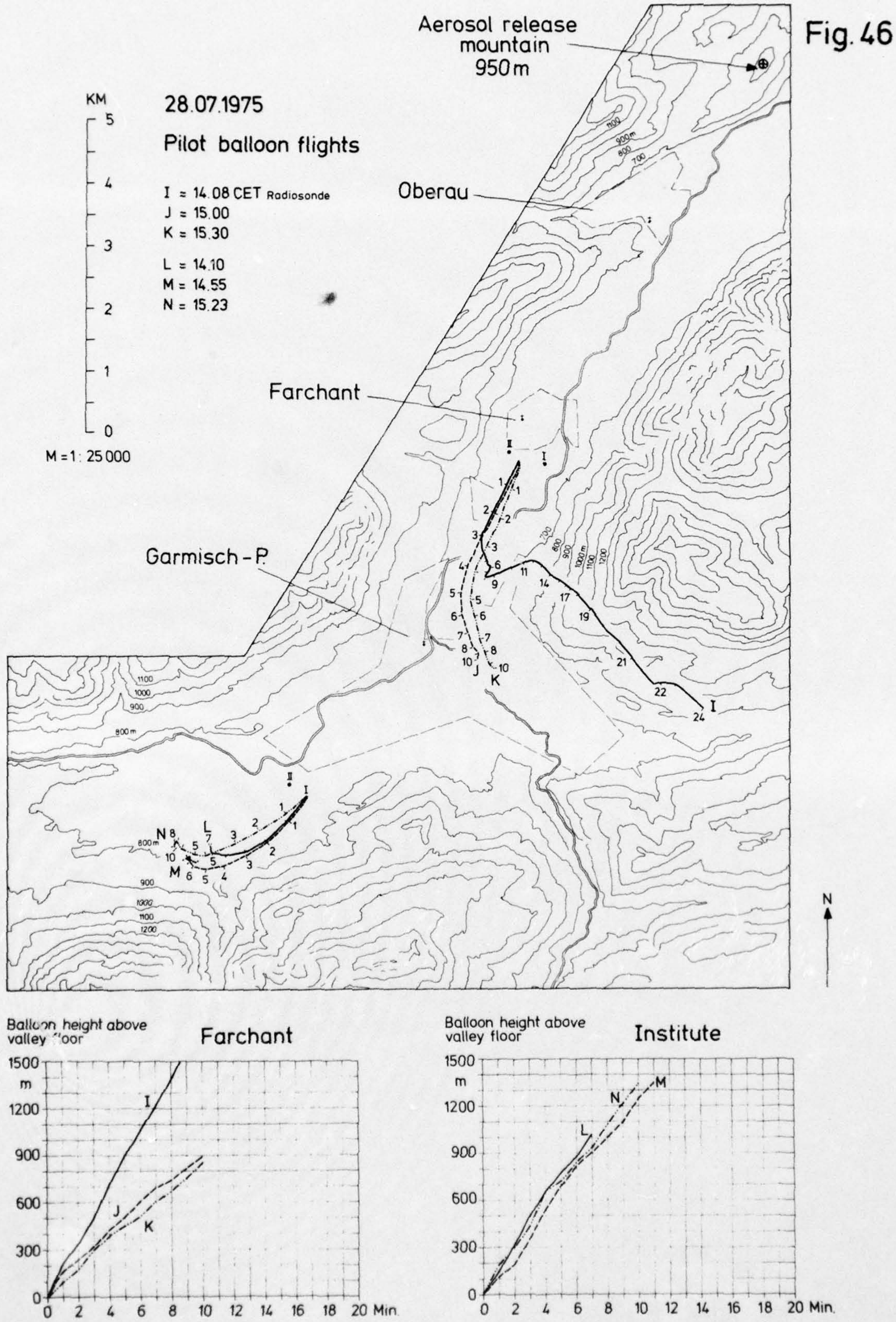
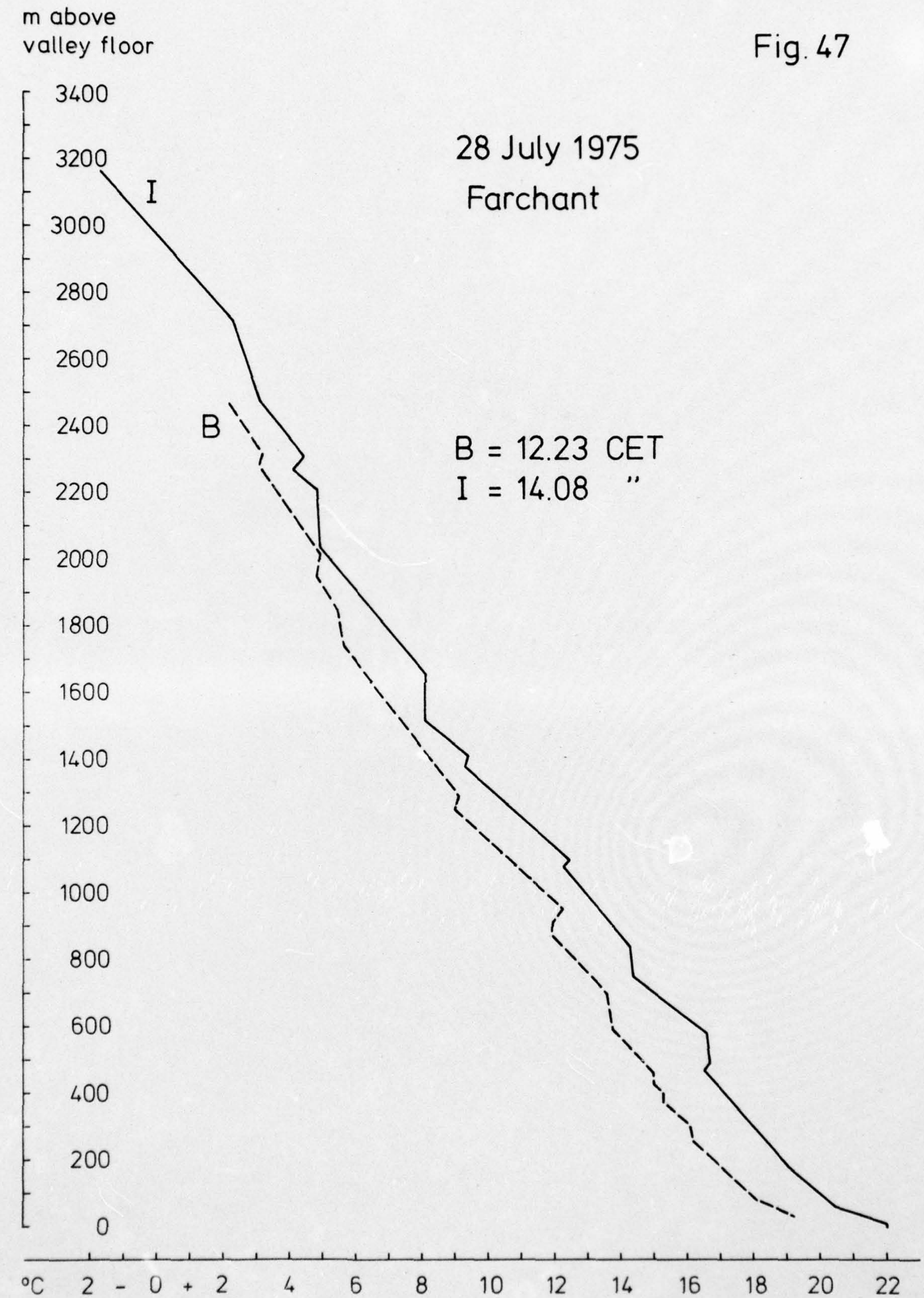


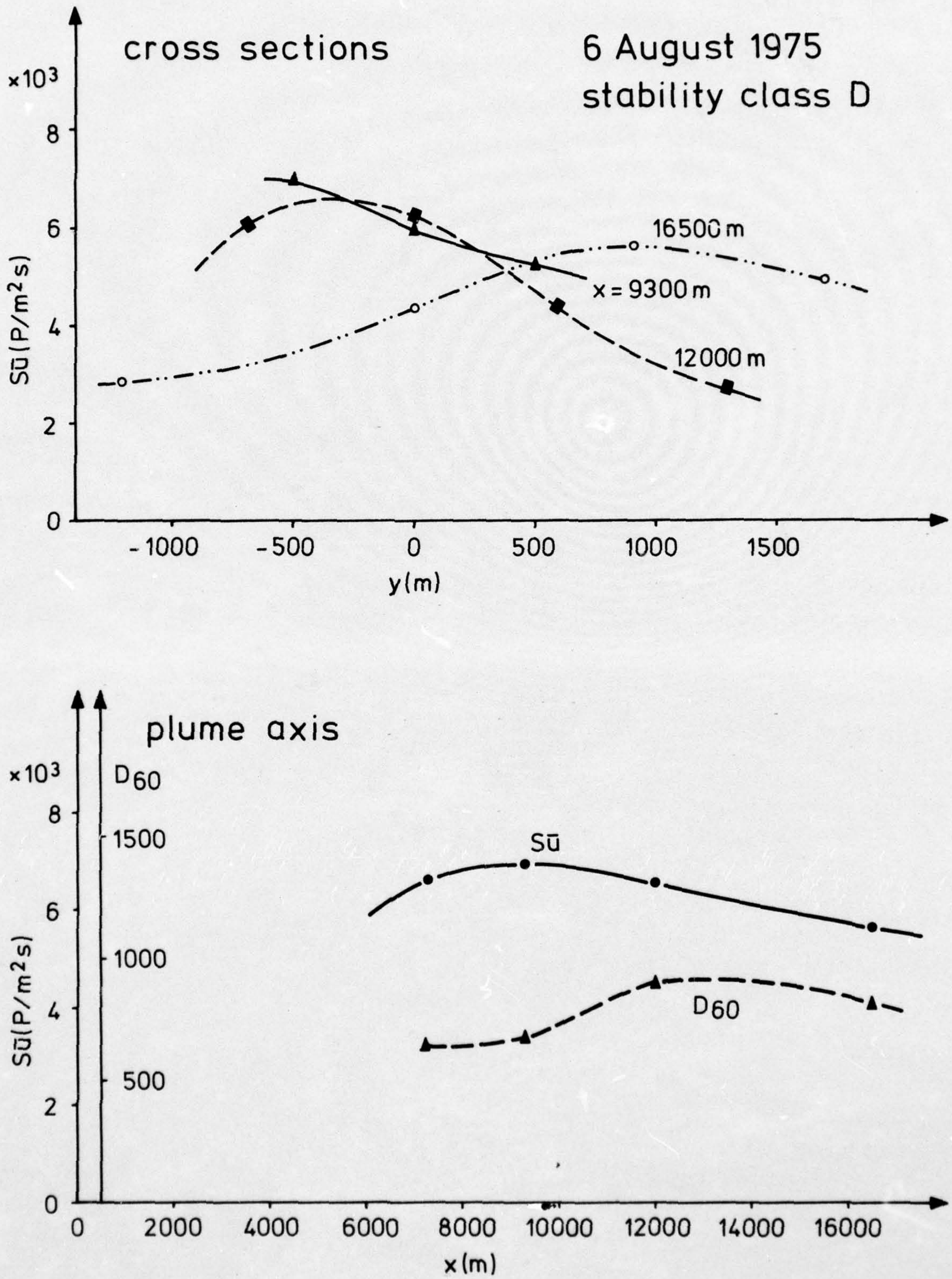
Fig. 46
Aerosol release mountain 950 m
28.07.1975
Pilot balloon flights
I = 14.08 CET Radiosonde
J = 15.00
K = 15.30
L = 14.10
M = 14.55
N = 15.23
KM
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Farchant
Institute
Min.

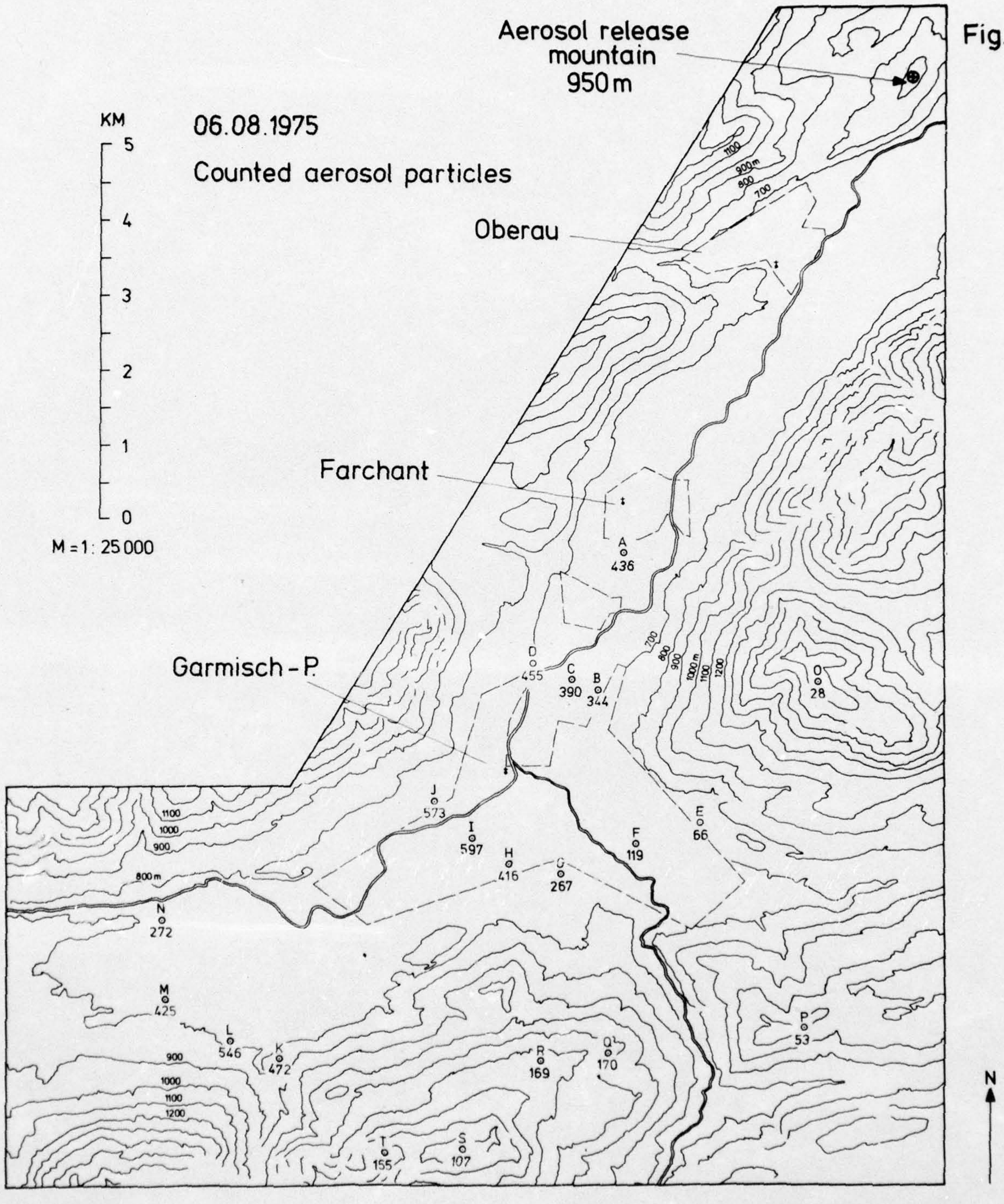
Fig. 47



m above
valley floor
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
28 July 1975
Farchant
I
B
B = 12.23 CET
I = 14.08 "
°C 2 - 0 + 2 4 6 8 10 12 14 16 18 20 22

Fig. 48


cross sections
6 August 1975
stability class D
x10³
Sū(P/m²s)
8
6
4
2
0
16500 m
x = 9300 m
12000 m
-1000
-500
0
500
1000
1500
y(m)
plume axis
x10³
D60
1500
1000
500
Sū
D60
0
2000
4000
6000
8000
10000
12000
14000
16000
x(m)



Aerosol release
mountain
950 m
06.08.1975
Counted aerosol particles
KM
5
4
3
2
1
0
M = 1: 25 000
Oberau
Farchant
Garmisch - P.
A 436
B 344
C 390
D 455
E 66
F 119
G 267
H 416
I 597
J 573
K 472
L 546
M 425
N 272
O 28
P 53
Q 170
R 169
S 107
T 155
N

Fig. 49

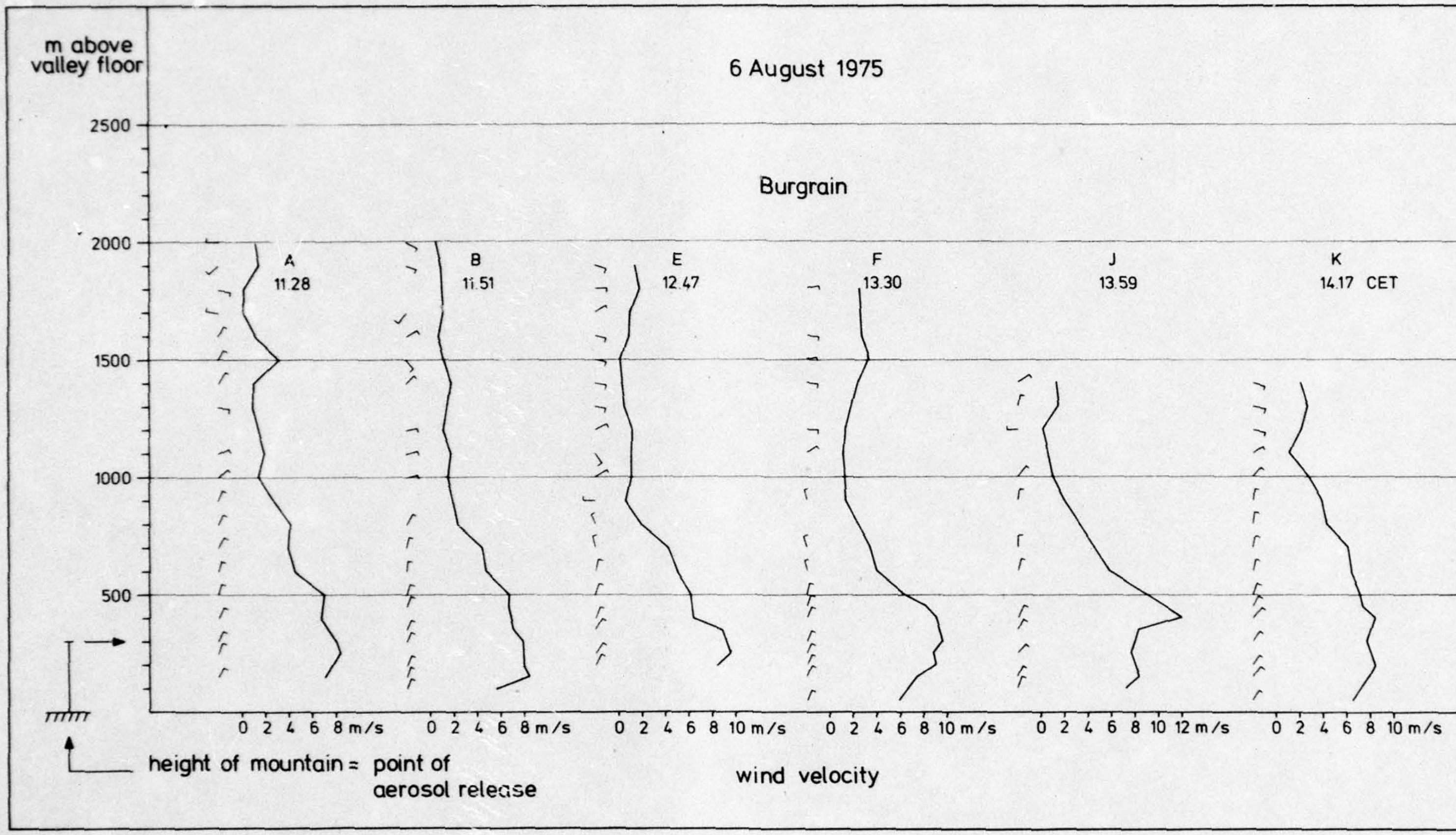
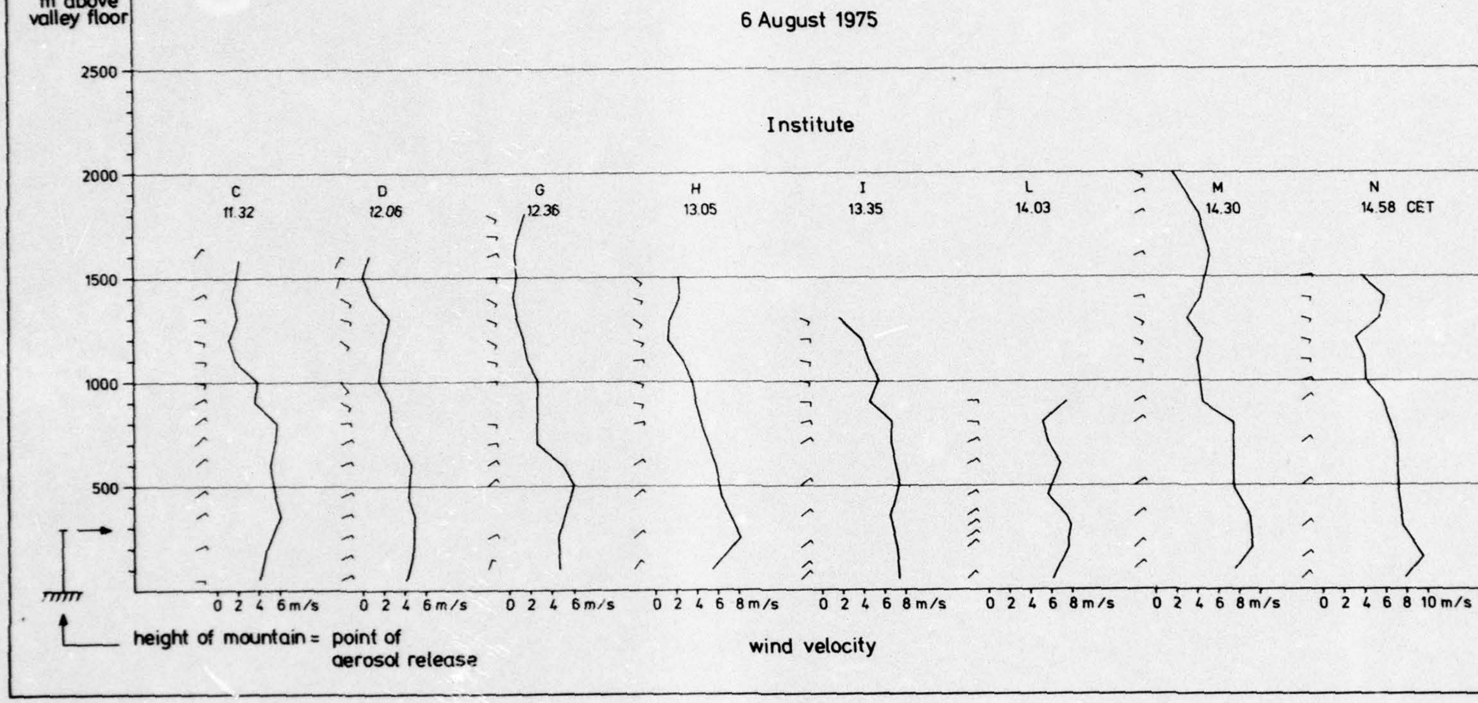

m above valley floor
6 August 1975
Burgrain
2500
2000
1500
1000
500
A 11.28
B 11.51
E 12.47
F 13.30
J 13.59
K 14.17 CET
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 10 m/s
0 2 4 6 8 10 m/s
0 2 4 6 8 10 12 m/s
0 2 4 6 8 10 m/s
height of mountain = point of aerosol release
wind velocity

Fig. 50

Fig. 51



m above
valley floor
2500
2000
1500
1000
500
6 August 1975
Institute
C
11.32
D
12.06
G
12.36
H
13.05
I
13.35
L
14.03
M
14.30
N
14.58 CET
0 2 4 6m/s
0 2 4 6m/s
0 2 4 6m/s
0 2 4 6 8m/s
0 2 4 6 8m/s
0 2 4 6 8m/s
0 2 4 6 8m/s
0 2 4 6 8 10m/s
wind velocity
height of mountain = point of
aerosol release

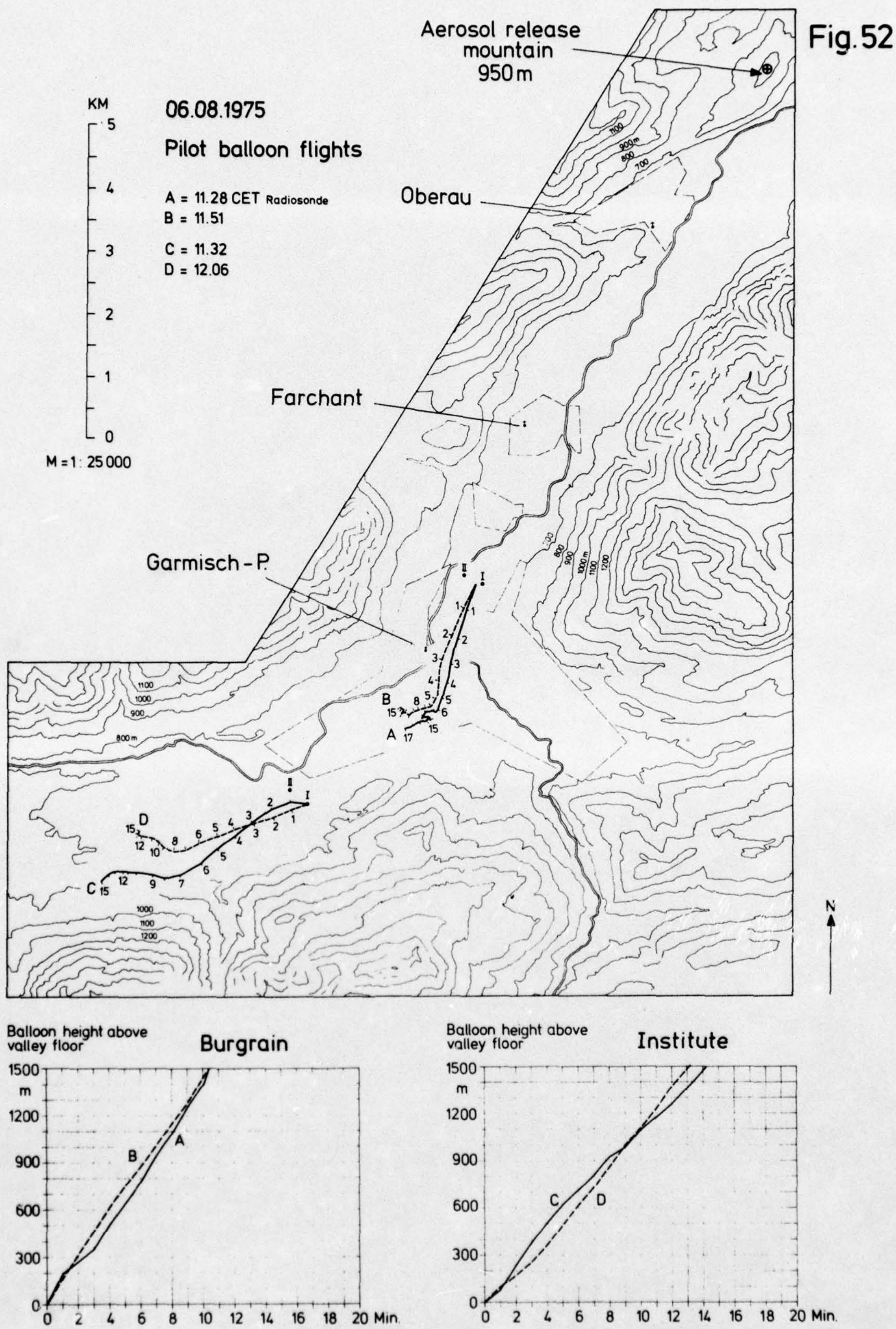


Fig.52
Aerosol release mountain 950 m
06.08.1975
Pilot balloon flights
A = 11.28 CET Radiosonde
B = 11.51
C = 11.32
D = 12.06
KM
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Burgrain
Institute
m
Min.

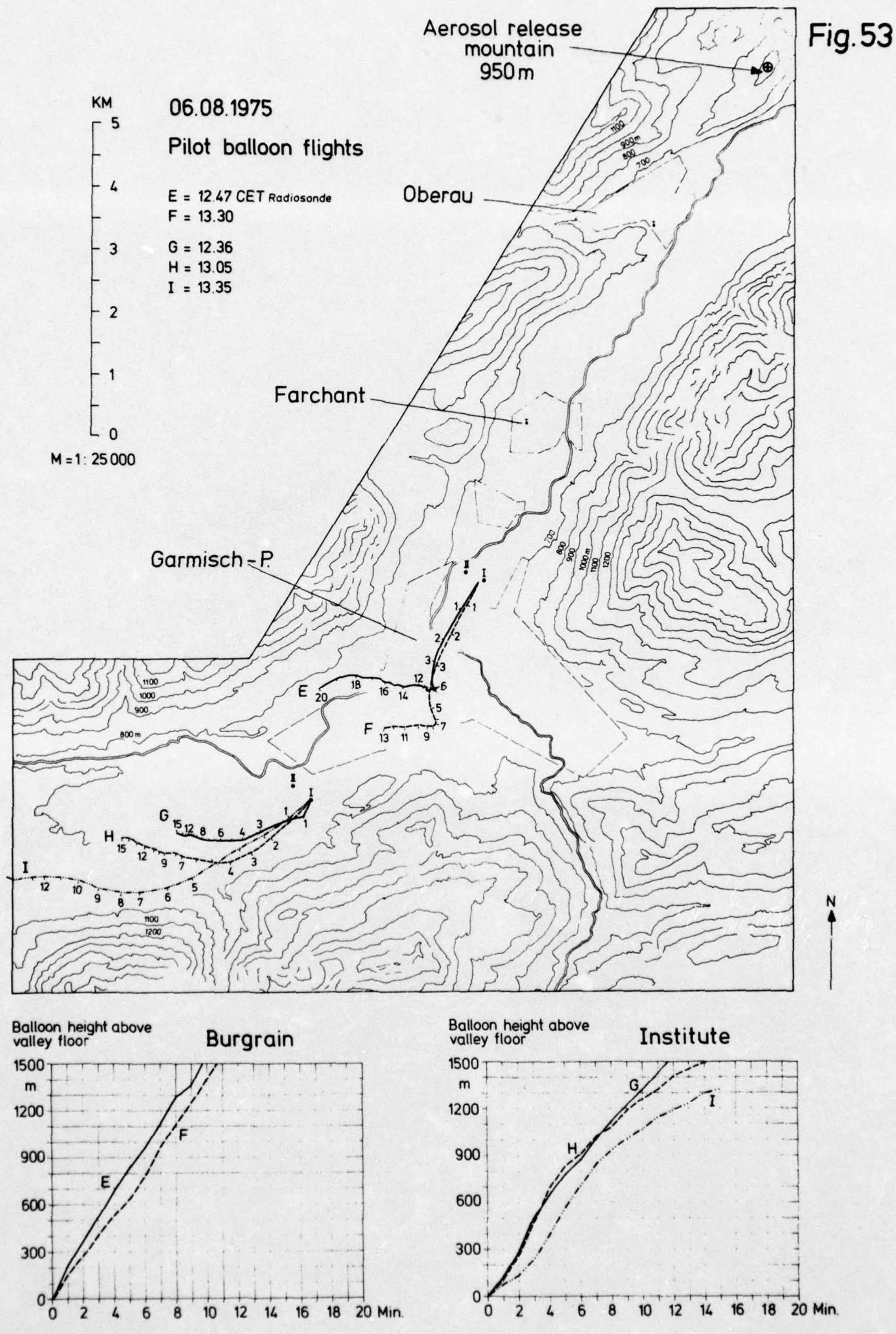
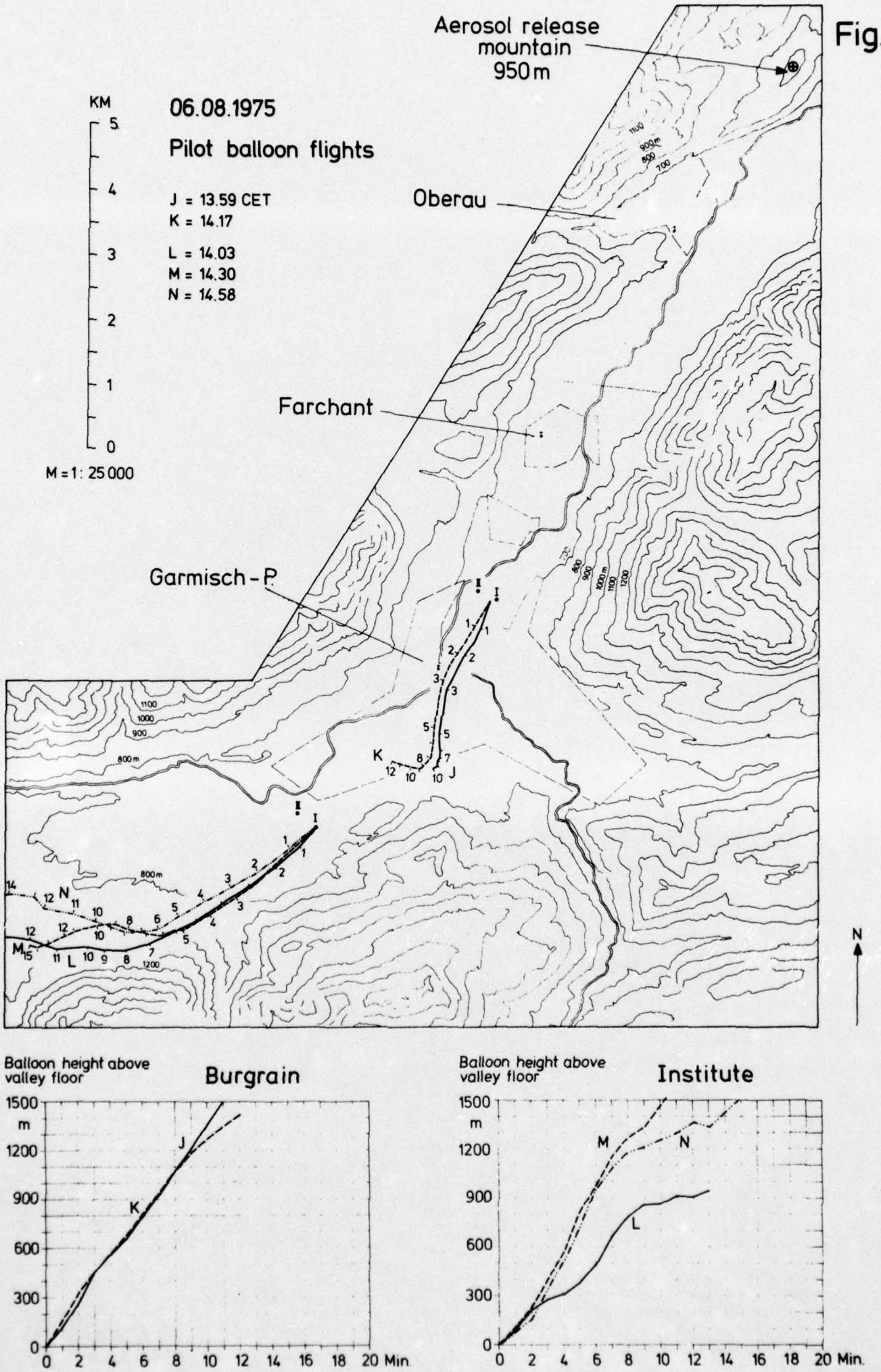
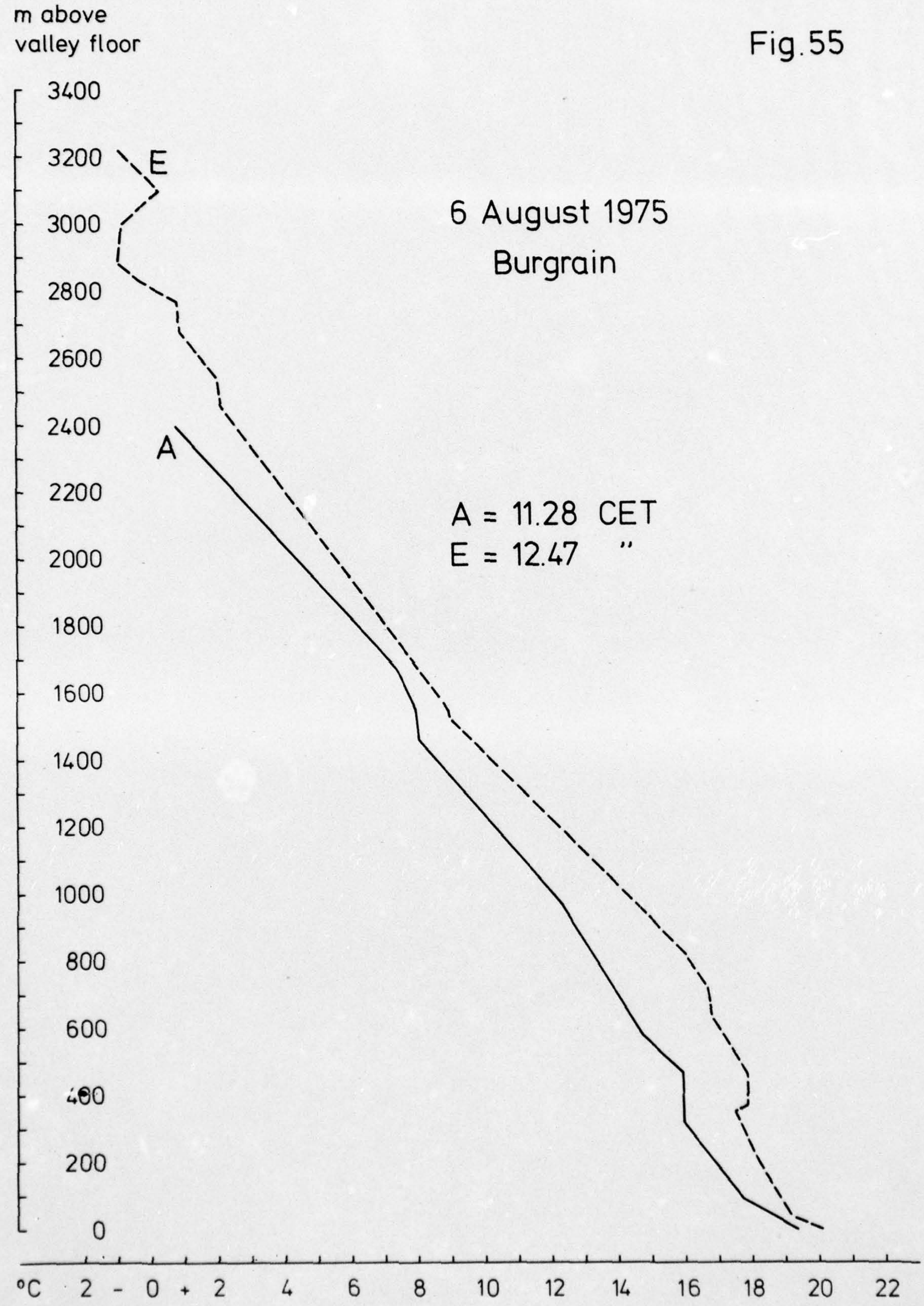


Fig.53
Aerosol release mountain 950 m
06.08.1975
Pilot balloon flights
E = 12.47 CET Radiosonde
F = 13.30
G = 12.36
H = 13.05
I = 13.35
KM
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Burgrain
Balloon height above valley floor
Institute
Min.

Fig.54

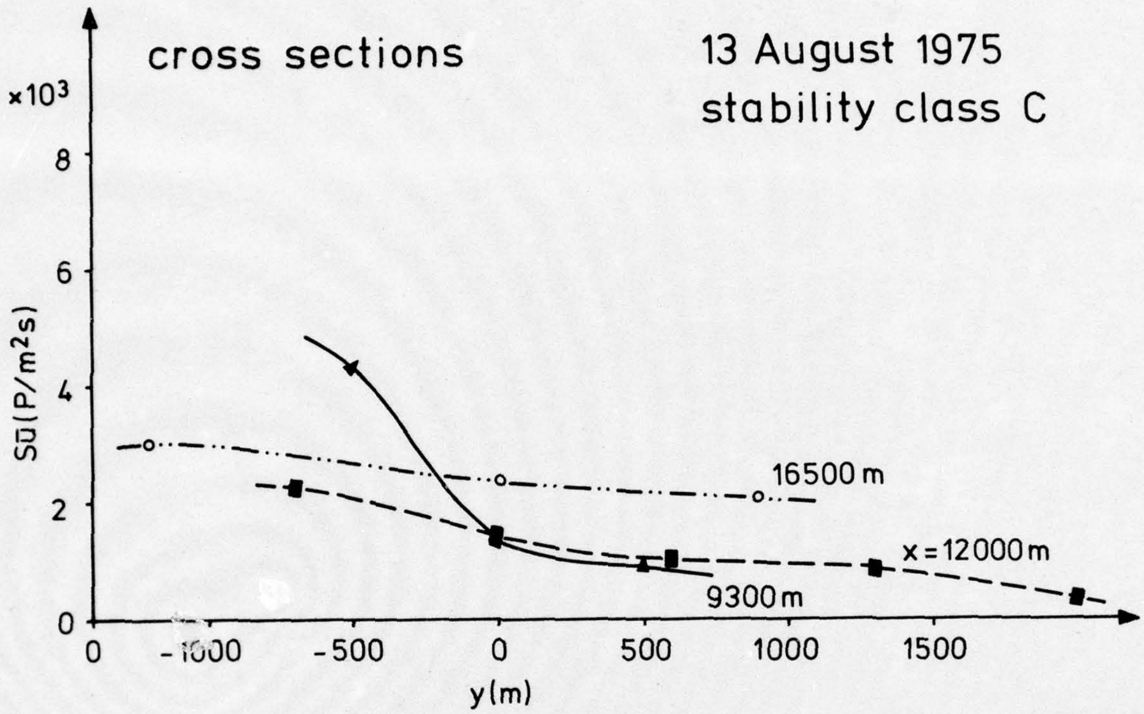


Aerosol release mountain 950 m
06.08.1975
Pilot balloon flights
J = 13.59 CET
K = 14.17
L = 14.03
M = 14.30
N = 14.58
KM
M = 1: 25 000
Oberau
Farchant
Garmisch - P.
N
Balloon height above valley floor
Burgrain
Institute
Min.

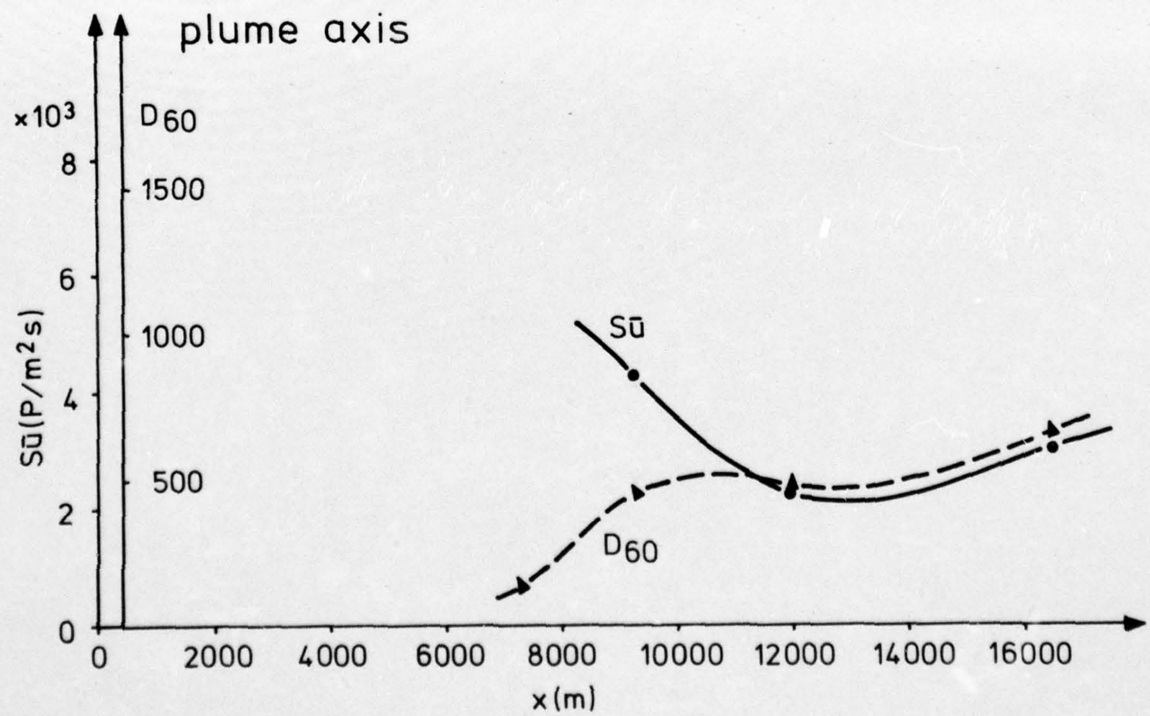


m above
valley floor
Fig. 55
6 August 1975
Burgrain
A = 11.28 CET
E = 12.47 "
A
E
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
°C 2 - 0 + 2 4 6 8 10 12 14 16 18 20 22

Fig. 56

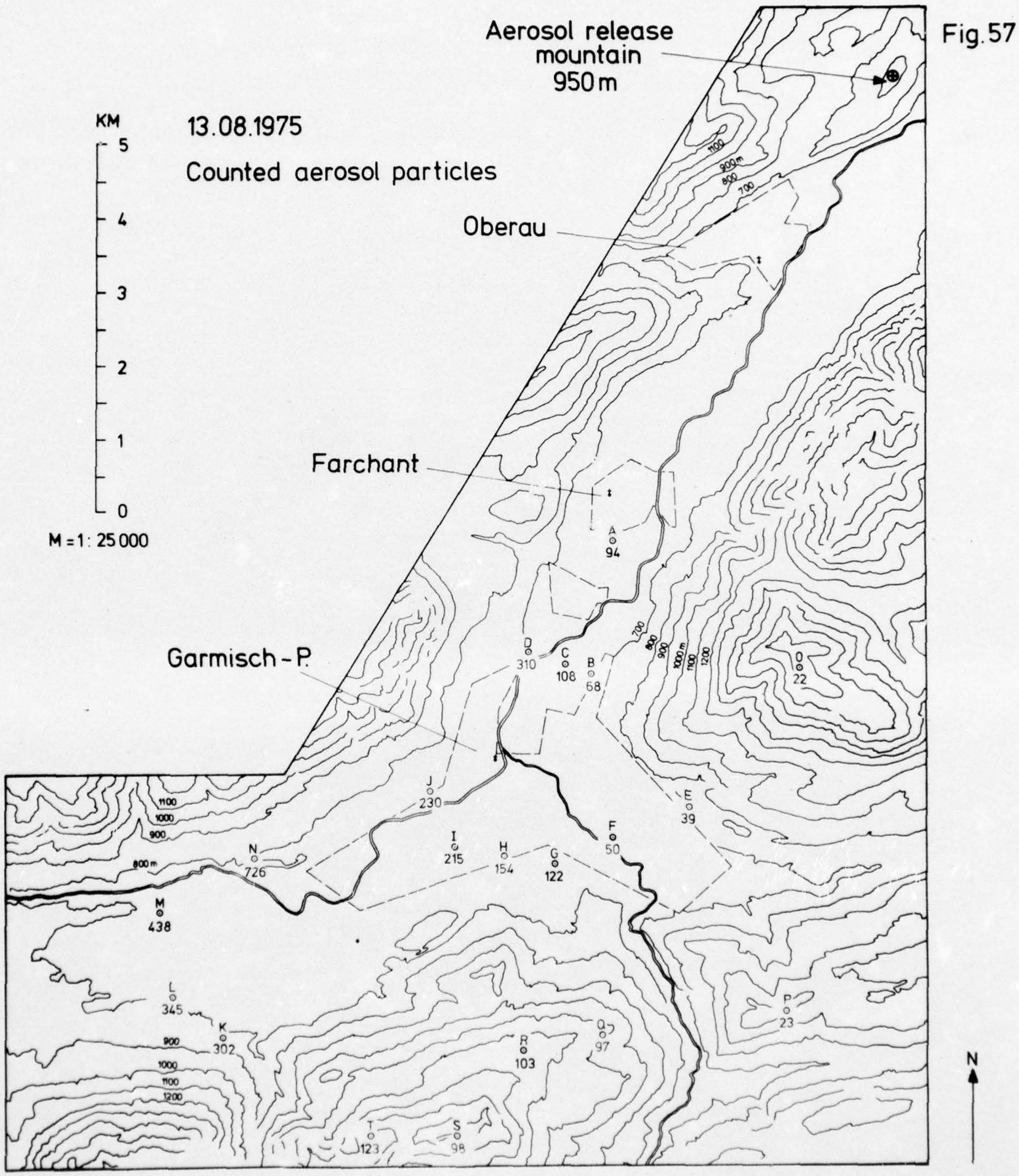


cross sections
13 August 1975
stability class C
×10³
Sū (P/m²s)
16500 m
x = 12000 m
9300 m
y (m)



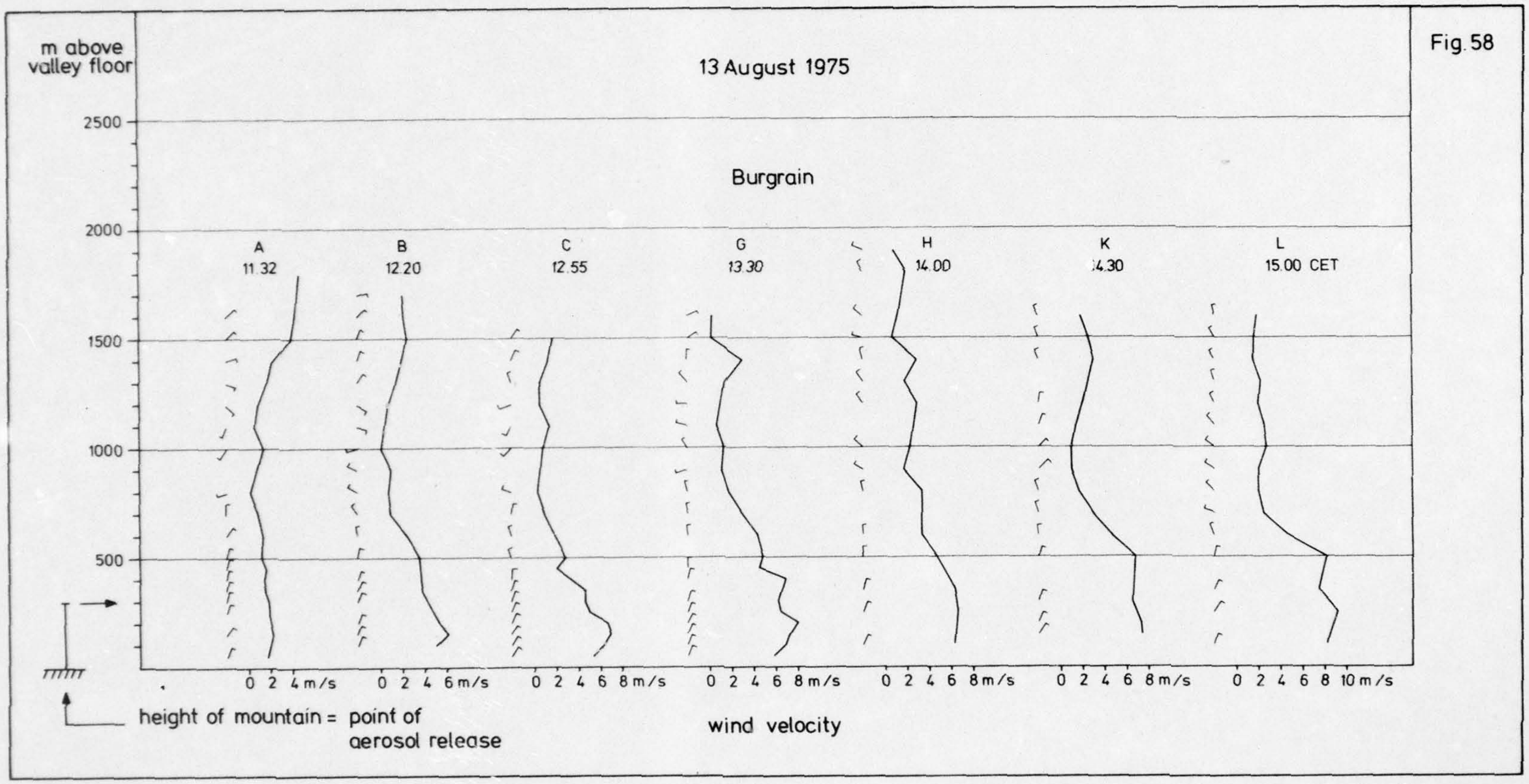
plume axis
×10³
D60
Sū (P/m²s)
Sū
D60
x (m)

Fig. 57



Aerosol release mountain 950 m
13.08.1975
Counted aerosol particles
KM
5
4
3
2
1
0
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
1100
900 m
800
700
A 94
B 68
C 108
D 310
E 39
F 50
G 122
H 154
I 215
J 230
K 302
L 345
M 438
N 726
O 22
P 23
Q 97
R 103
S 98
T 123
1000
1200
1000 m
800 m
N

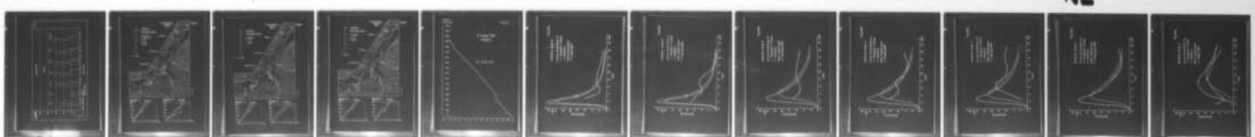
Fig. 58

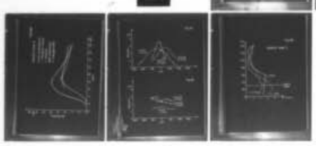

m above
valley floor
13 August 1975
2500
2000
1500
1000
500
Burgrain
A
11.32
B
12.20
C
12.55
G
13.30
H
14.00
K
14.30
L
15.00 CET
0 2 4 m/s
0 2 4 6 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 m/s
0 2 4 6 8 10 m/s
height of mountain = point of
aerosol release
wind velocity

AD-A031 804 FRAUNHOFER-GESELLSCHAFT GARMISCH-PARTENKIRCHEN (WEST --ETC F/G 4/1
BOUNDARY LAYER AEROSOL TRANSPORT MEASUREMENTS IN A VALLEY SYSTE--ETC(U)
JUL 76 R REITER, R SLADKOVIC DA-ERO-75-G-042

UNCLASSIFIED NL

2 OF 2
AD
A031804

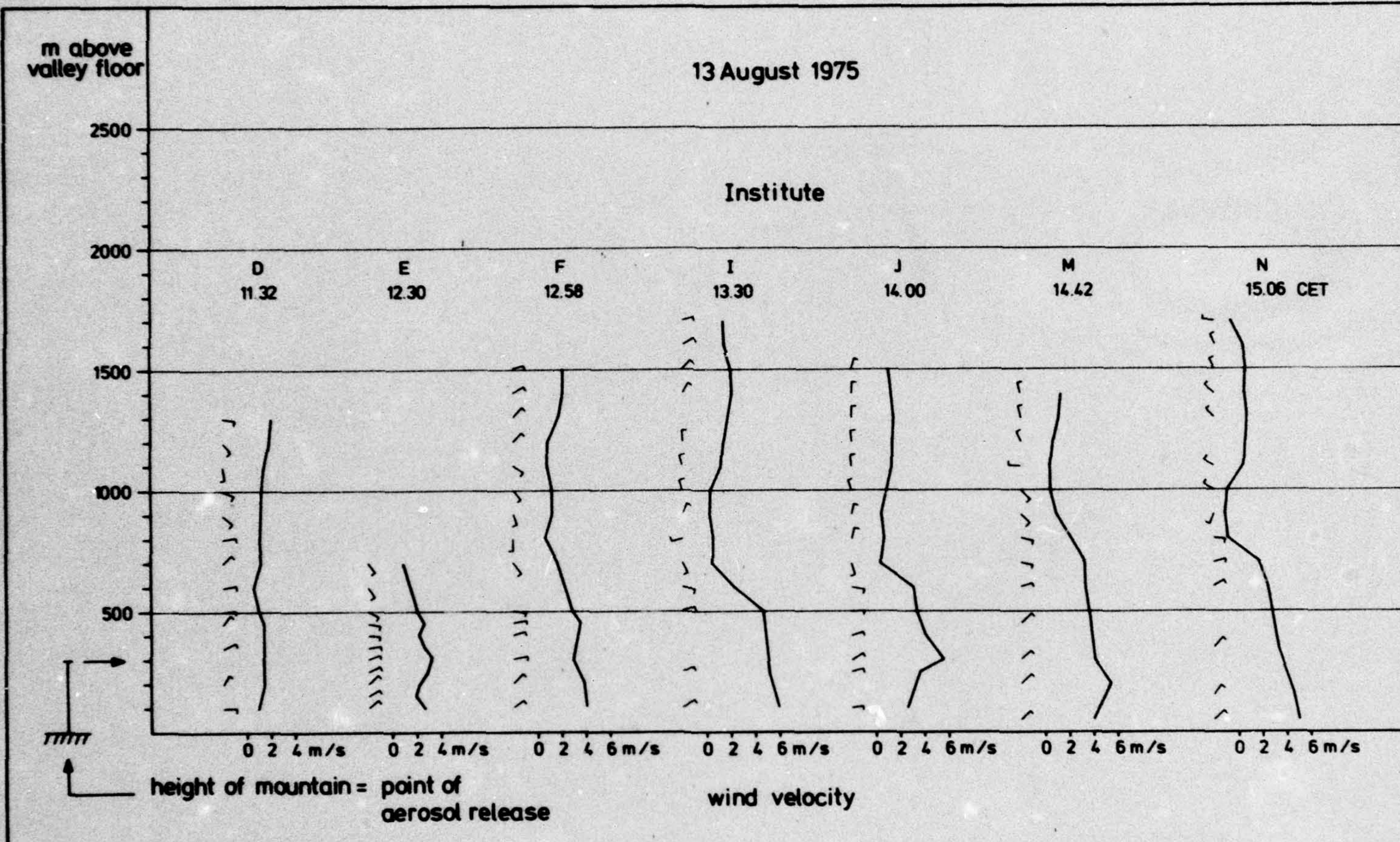




END

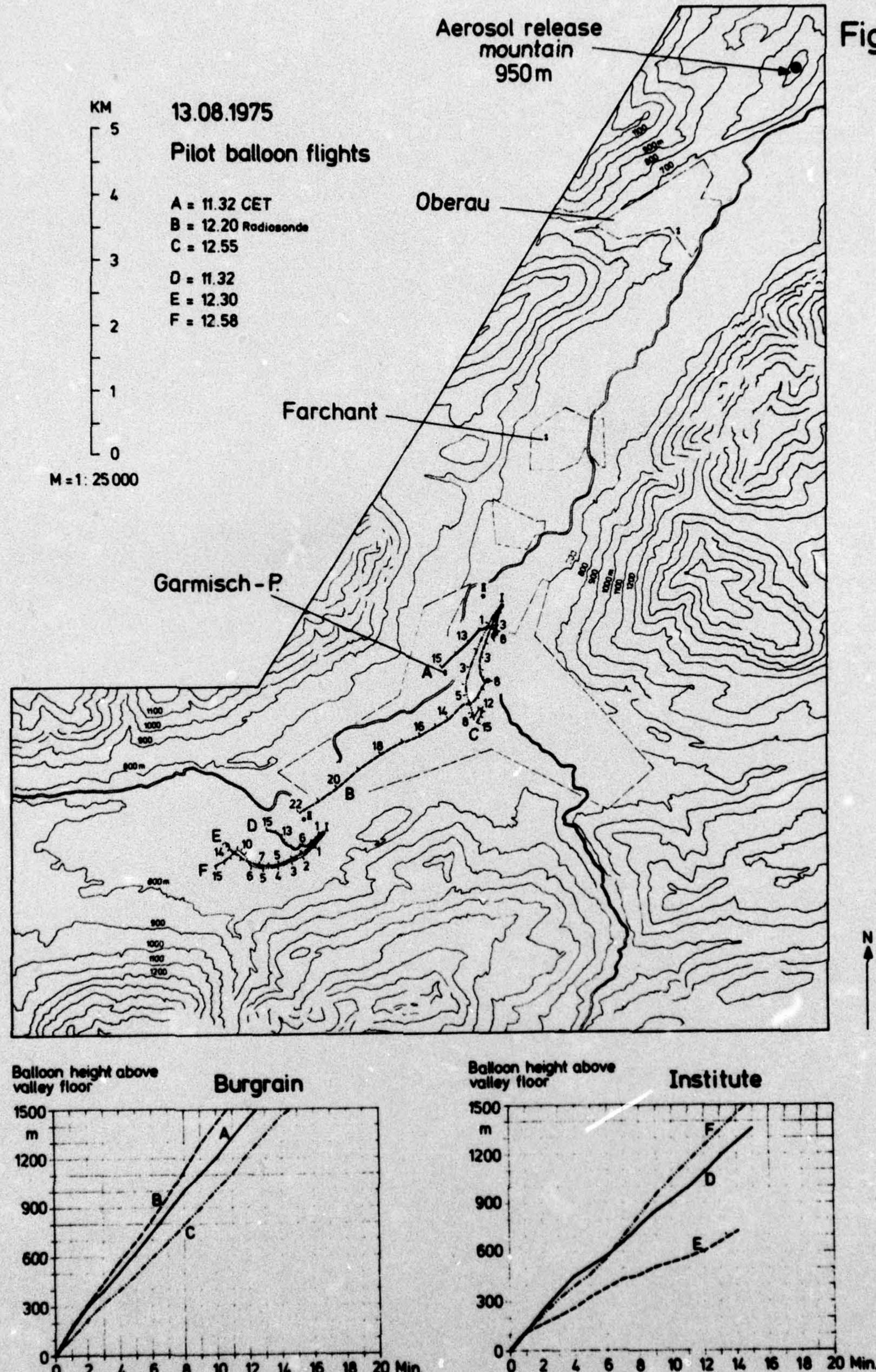
DATE
FILMED
12-76

Fig. 59



m above valley floor
13 August 1975
Institute
2500
2000
1500
1000
500
D 11.32
E 12.30
F 12.58
I 13.30
J 14.00
M 14.42
N 15.06 CET
0 2 4 m/s
0 2 4 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
0 2 4 6 m/s
height of mountain = point of aerosol release
wind velocity

Fig.60


Aerosol release mountain 950 m
13.08.1975
Pilot balloon flights
A = 11.32 CET
B = 12.20 Radiosonde
C = 12.55
D = 11.32
E = 12.30
F = 12.58
KM
M = 1: 25 000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Burgrain
Institute
m
Min.

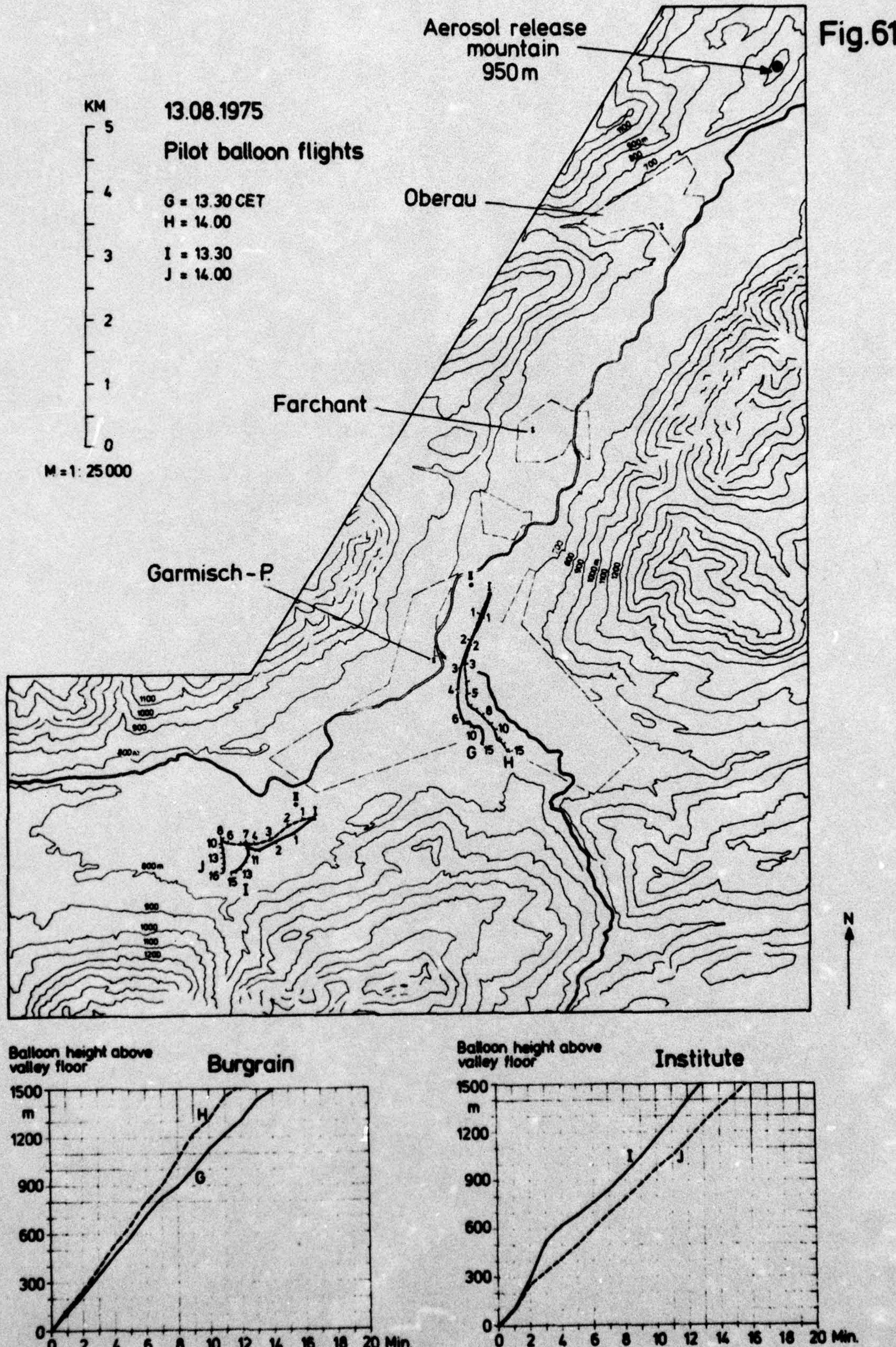


Fig.61
Aerosol release mountain 950m
13.08.1975
Pilot balloon flights
G = 13.30 CET
H = 14.00
I = 13.30
J = 14.00
KM
M = 1: 25000
Oberau
Farchant
Garmisch-P.
N
Balloon height above valley floor
Burgrain
Institute
1500 m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.

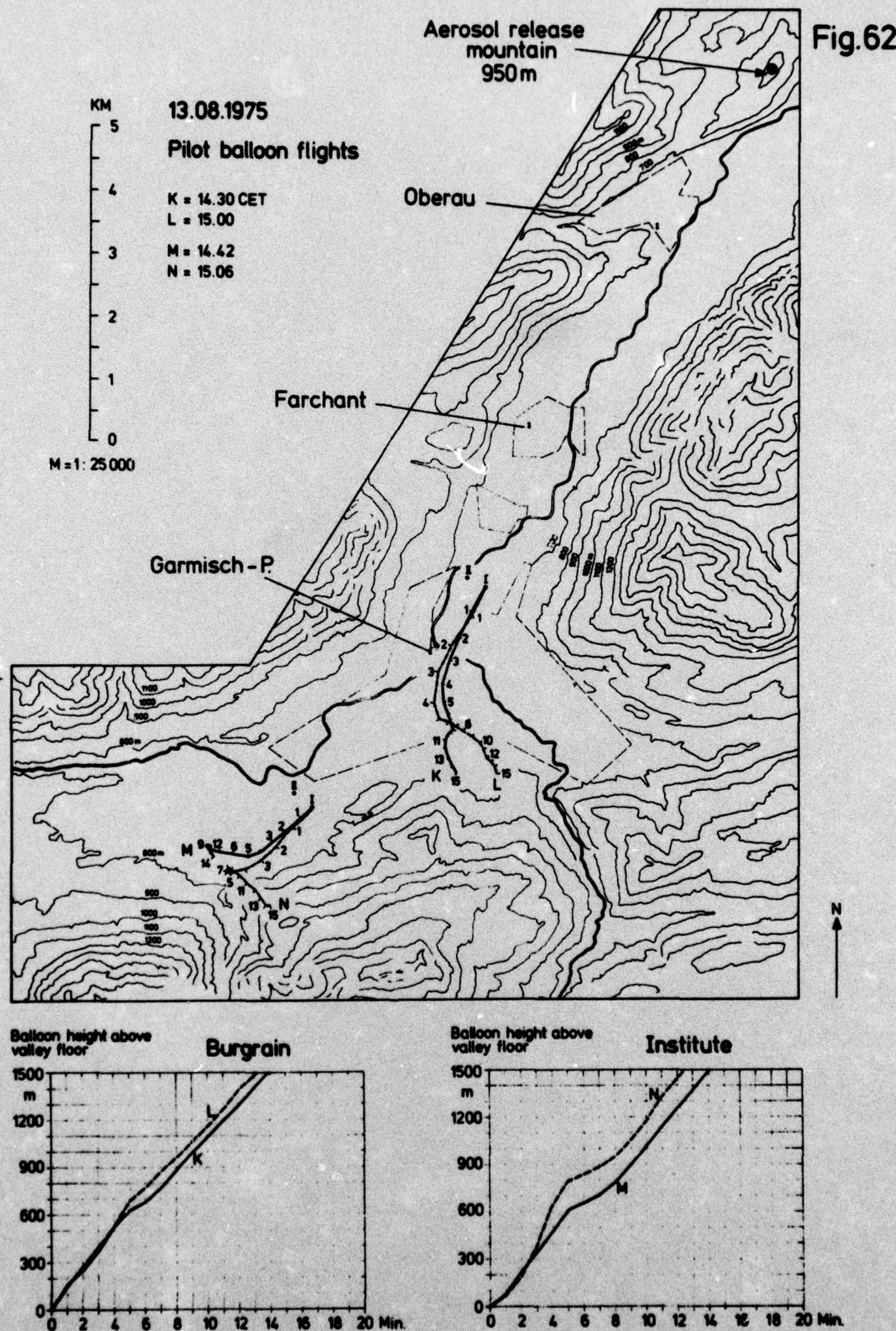
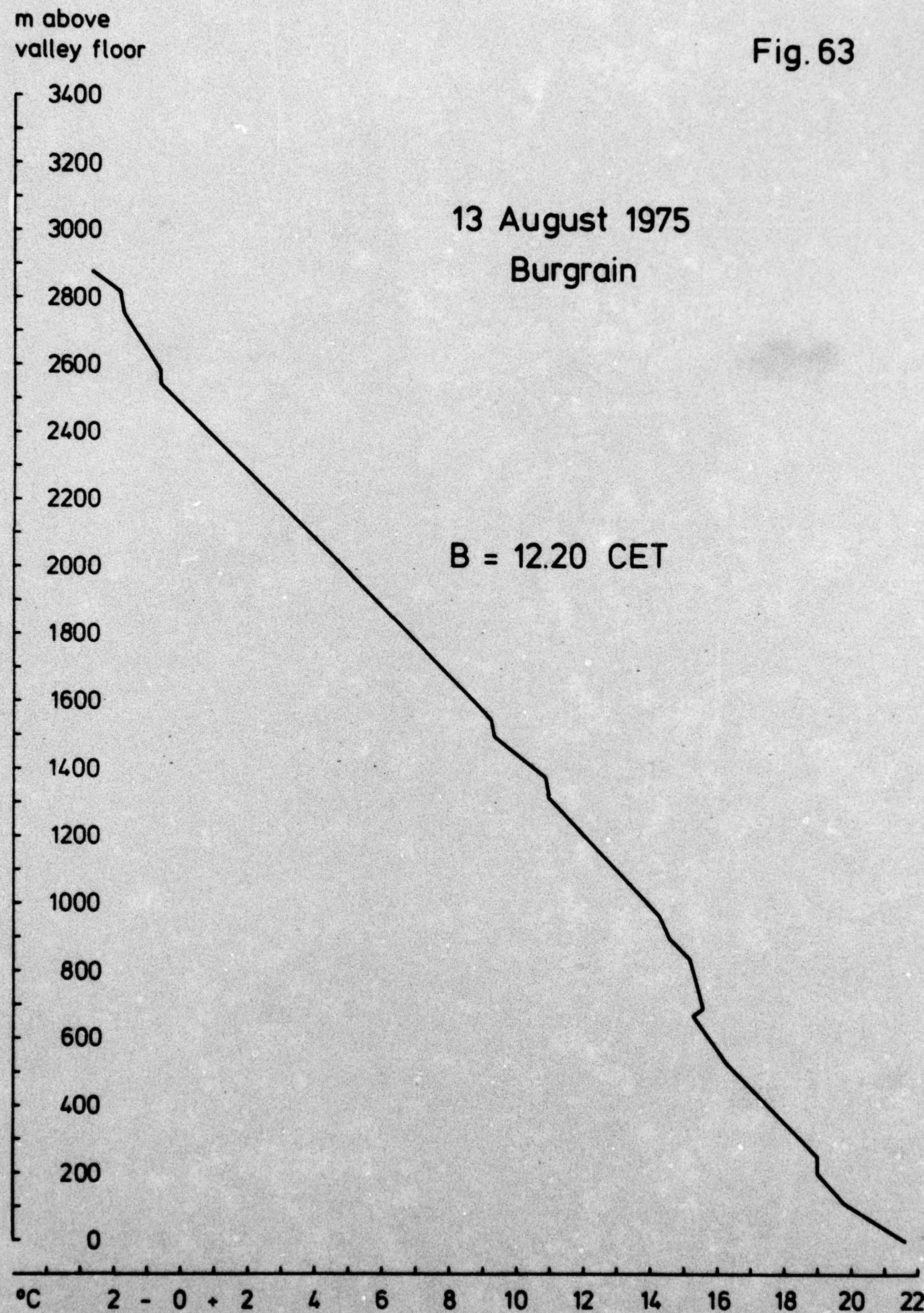


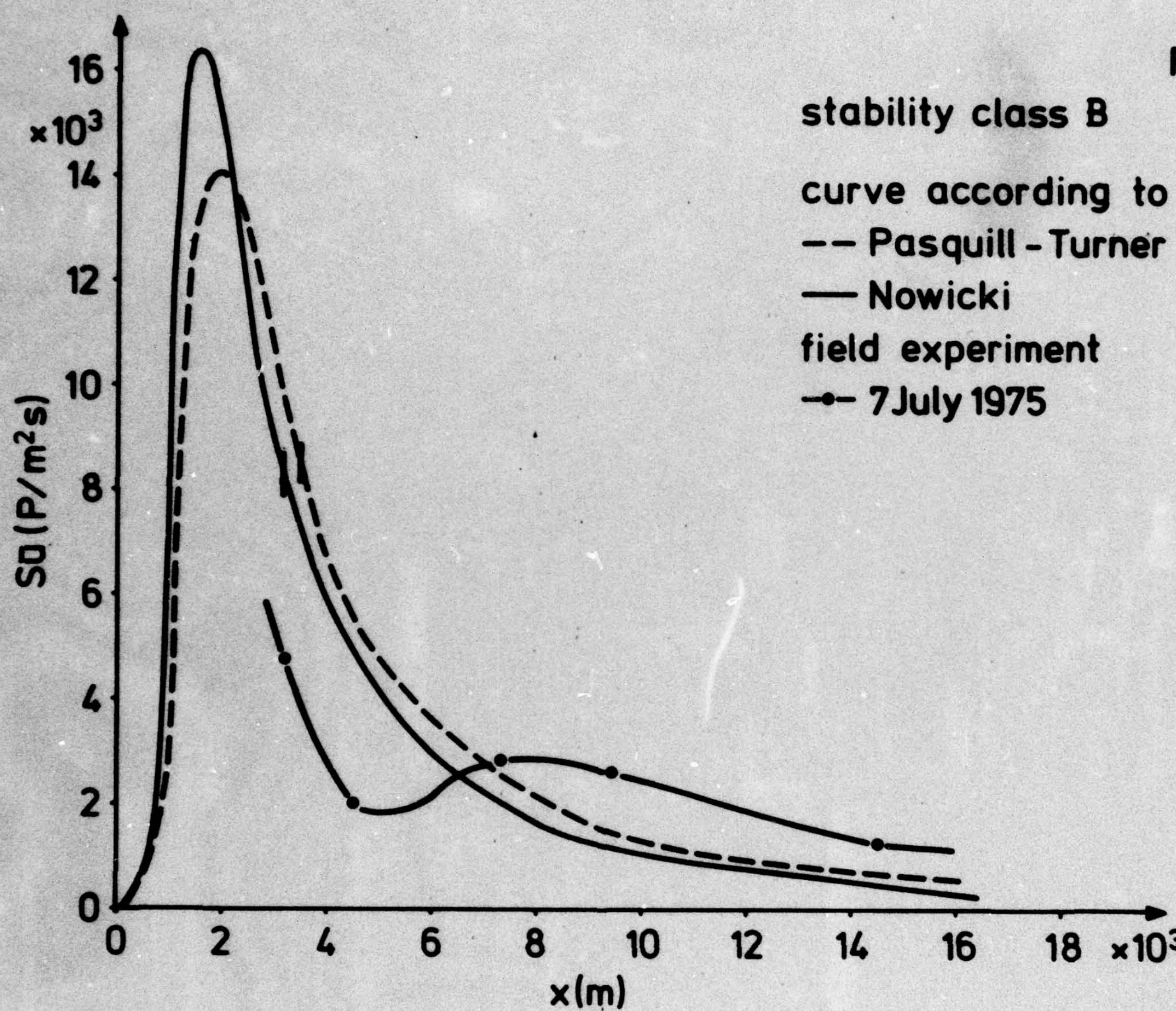
Fig.62
13.08.1975
Pilot balloon flights
K = 14.30 CET
L = 15.00
M = 14.42
N = 15.06
KM
5
4
3
2
1
0
M = 1: 25 000
Aerosol release mountain 950m
Oberau
Farchant
Garmisch - P.
K
L
M
N
N
Balloon height above valley floor
Burgrain
Institute
1500
m
1200
900
600
300
0
0 2 4 6 8 10 12 14 16 18 20 Min.

Fig. 63



m above
valley floor
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
13 August 1975
Burgrain
B = 12.20 CET
°C
2 - 0 + 2
4
6
8
10
12
14
16
18
20
22

Fig. 64a


stability class B
curve according to
-- Pasquill - Turner
— Nowicki
field experiment
-•- 7 July 1975
SΩ (P/m²s)
×10³
16
14
12
10
8
6
4
2
0
x(m)
0
2
4
6
8
10
12
14
16
18
×10³

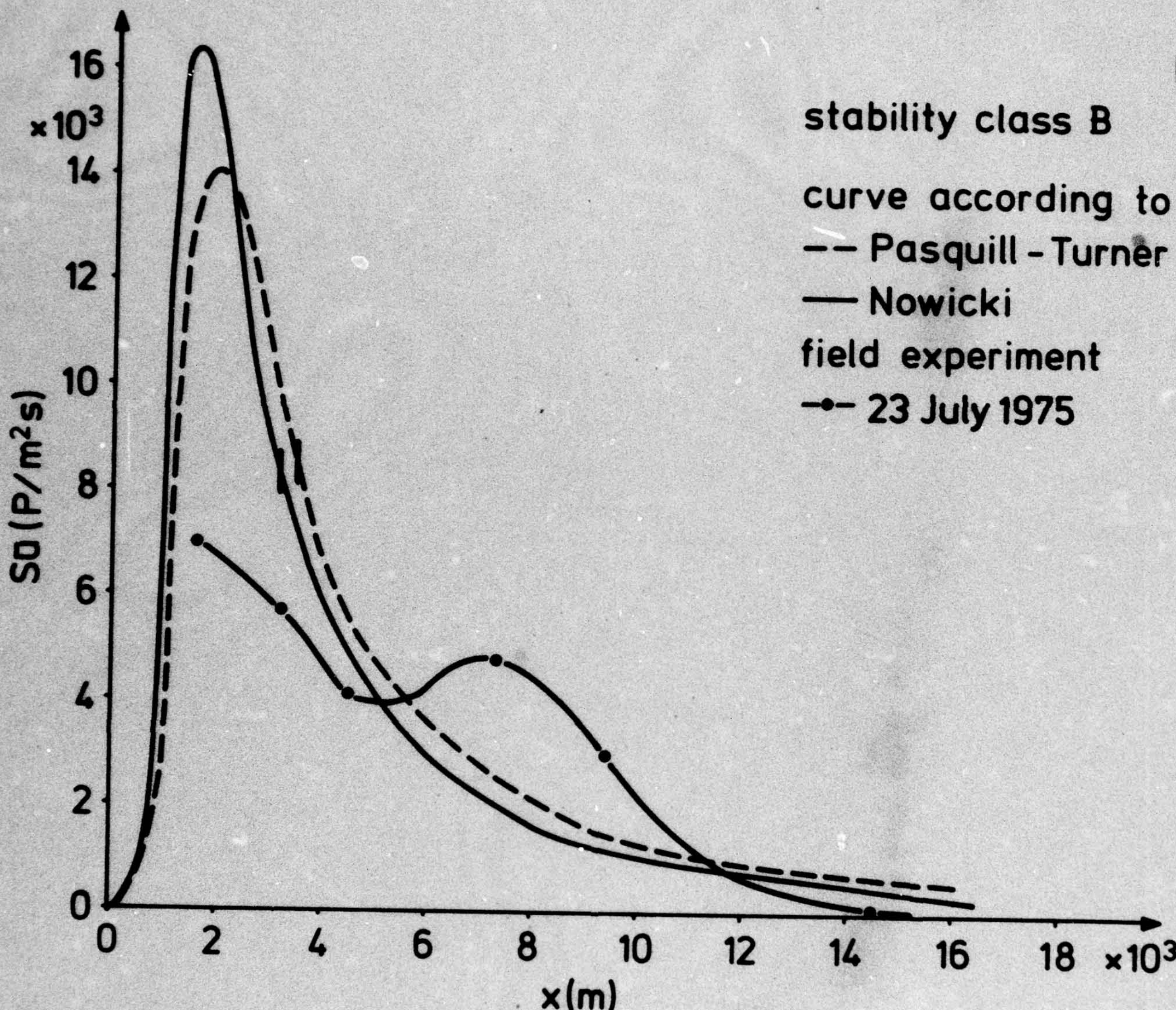
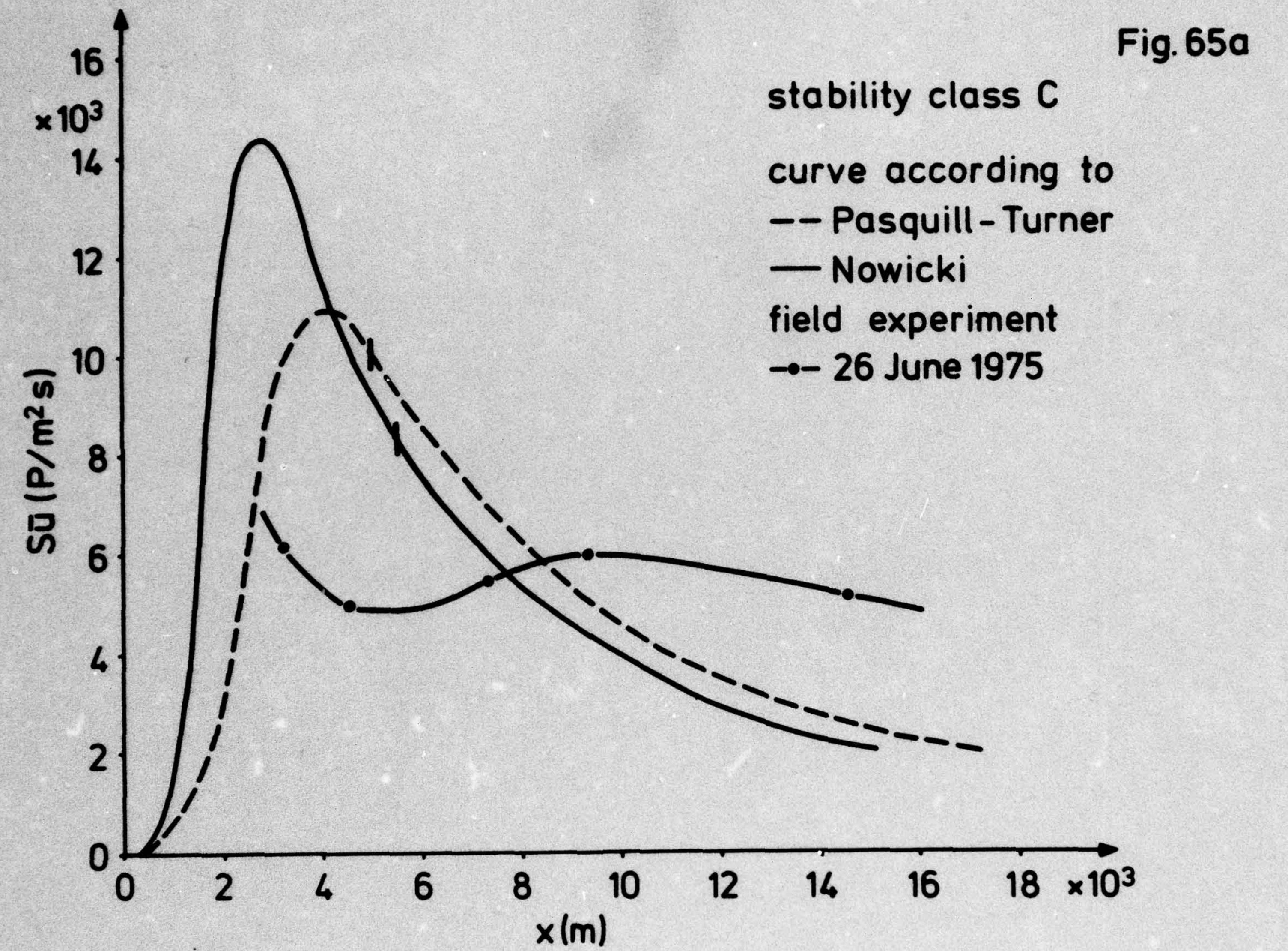

stability class B
curve according to
Pasquill - Turner
Nowicki
field experiment
23 July 1975
16
$\times 10^3$
14
12
10
8
6
4
2
0
$S\Omega\,(P/m^2s)$
0
2
4
6
8
10
12
14
16
18
$\times 10^3$
x(m)

Fig. 64b

Fig. 65a


stability class C
curve according to
Pasquill-Turner
Nowicki
field experiment
26 June 1975
$S\bar{u}$ (P/m²s)
×10³
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
×10³
x (m)

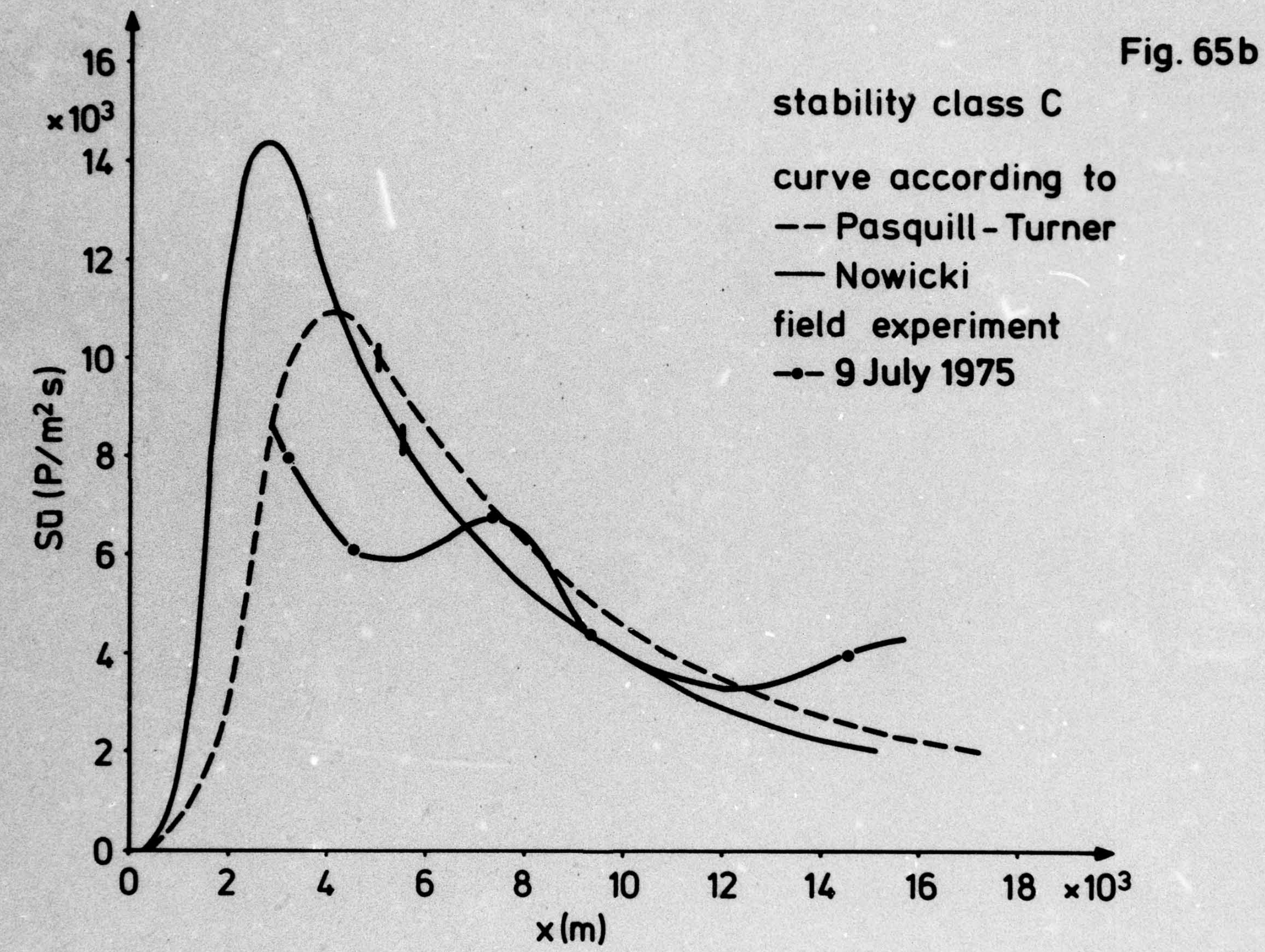
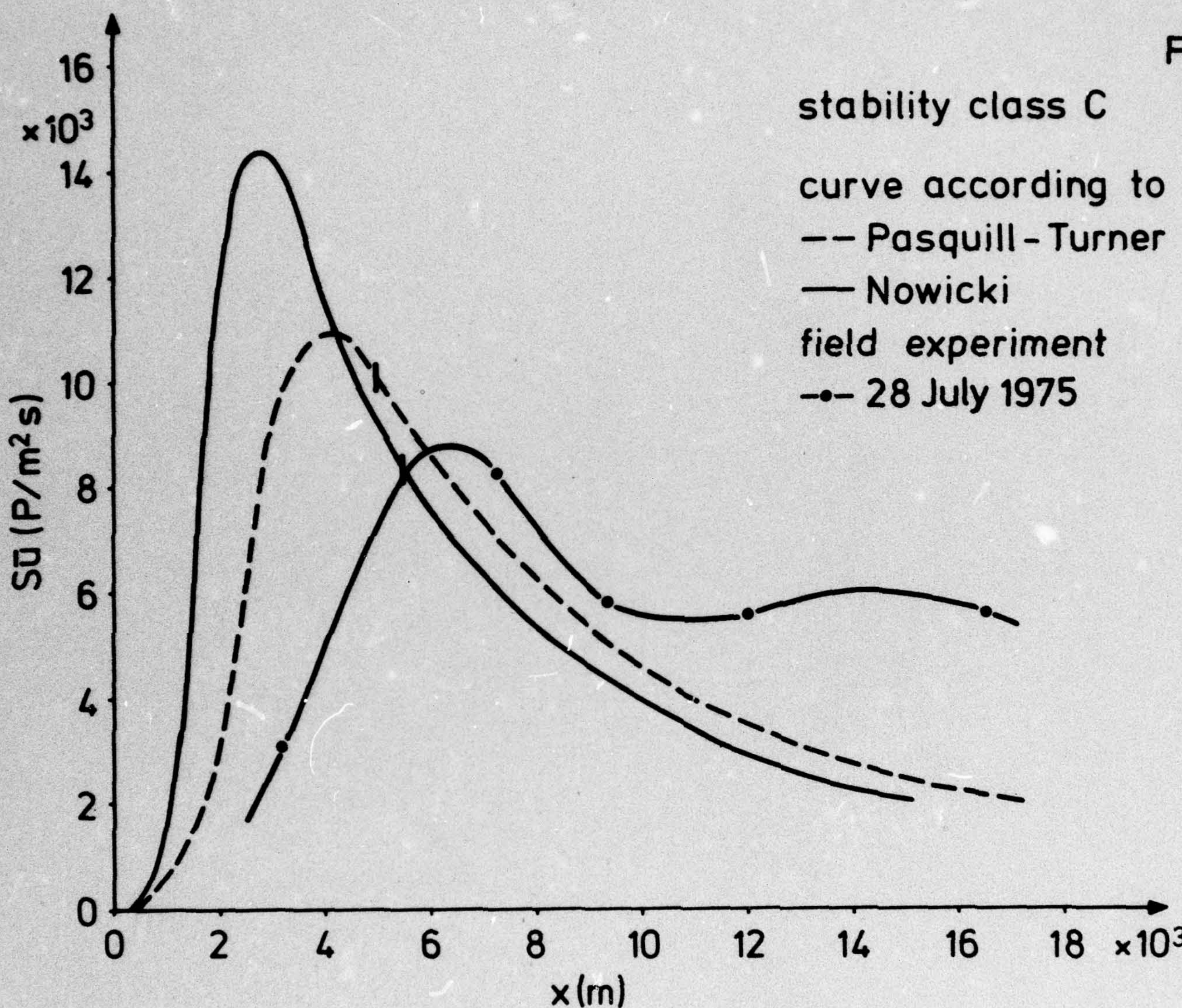


Fig. 65b
stability class C
curve according to
Pasquill - Turner
Nowicki
field experiment
9 July 1975
16
$\times 10^3$
14
12
10
8
6
4
2
0
SΩ (P/m² s)
0
2
4
6
8
10
12
14
16
18
$\times 10^3$
x (m)

Fig. 65c



stability class C
curve according to
-- Pasquill - Turner
— Nowicki
field experiment
-•- 28 July 1975
Sū (P/m²s)
×10³
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
×10³
x(m)

Fig. 65 d

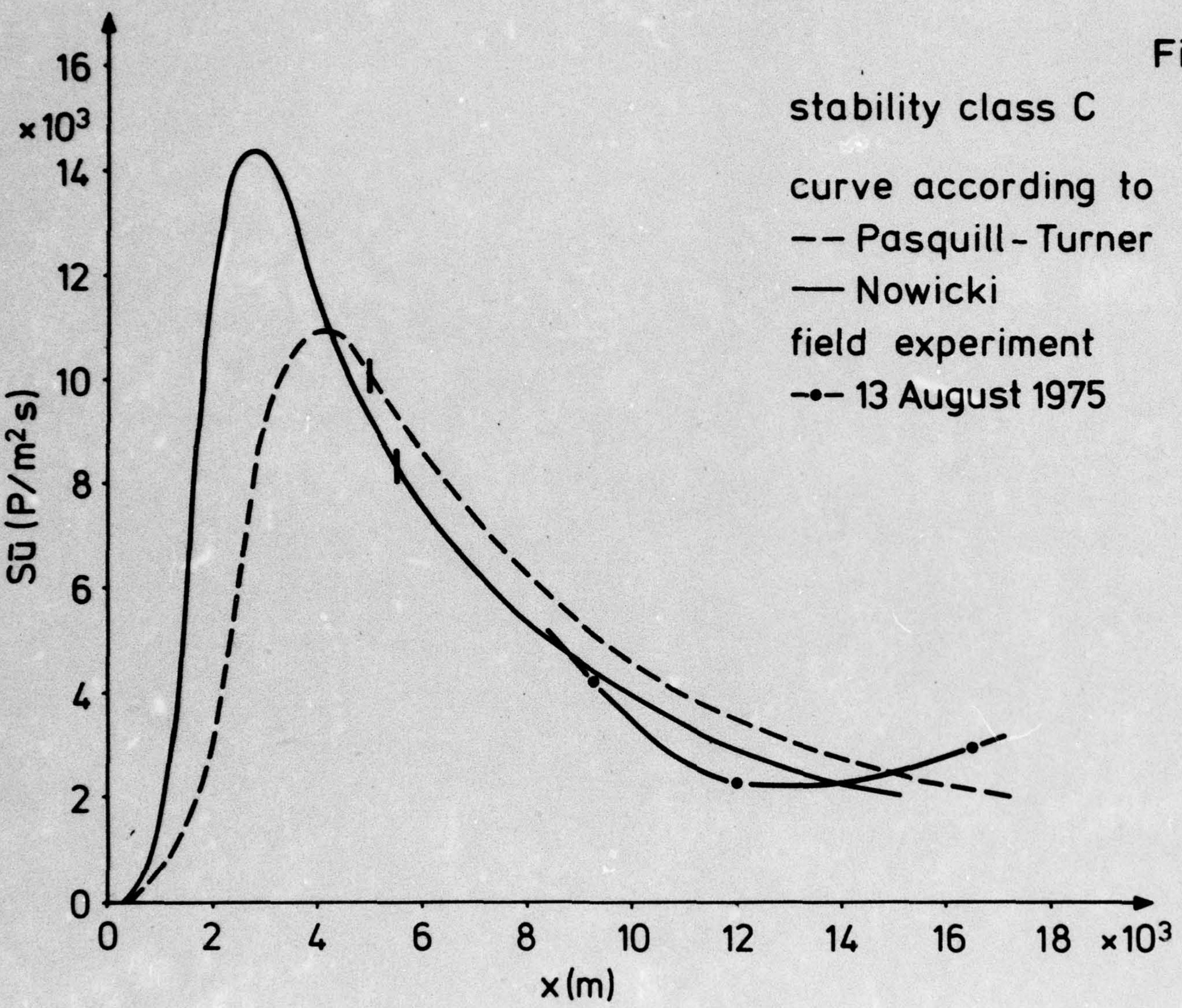
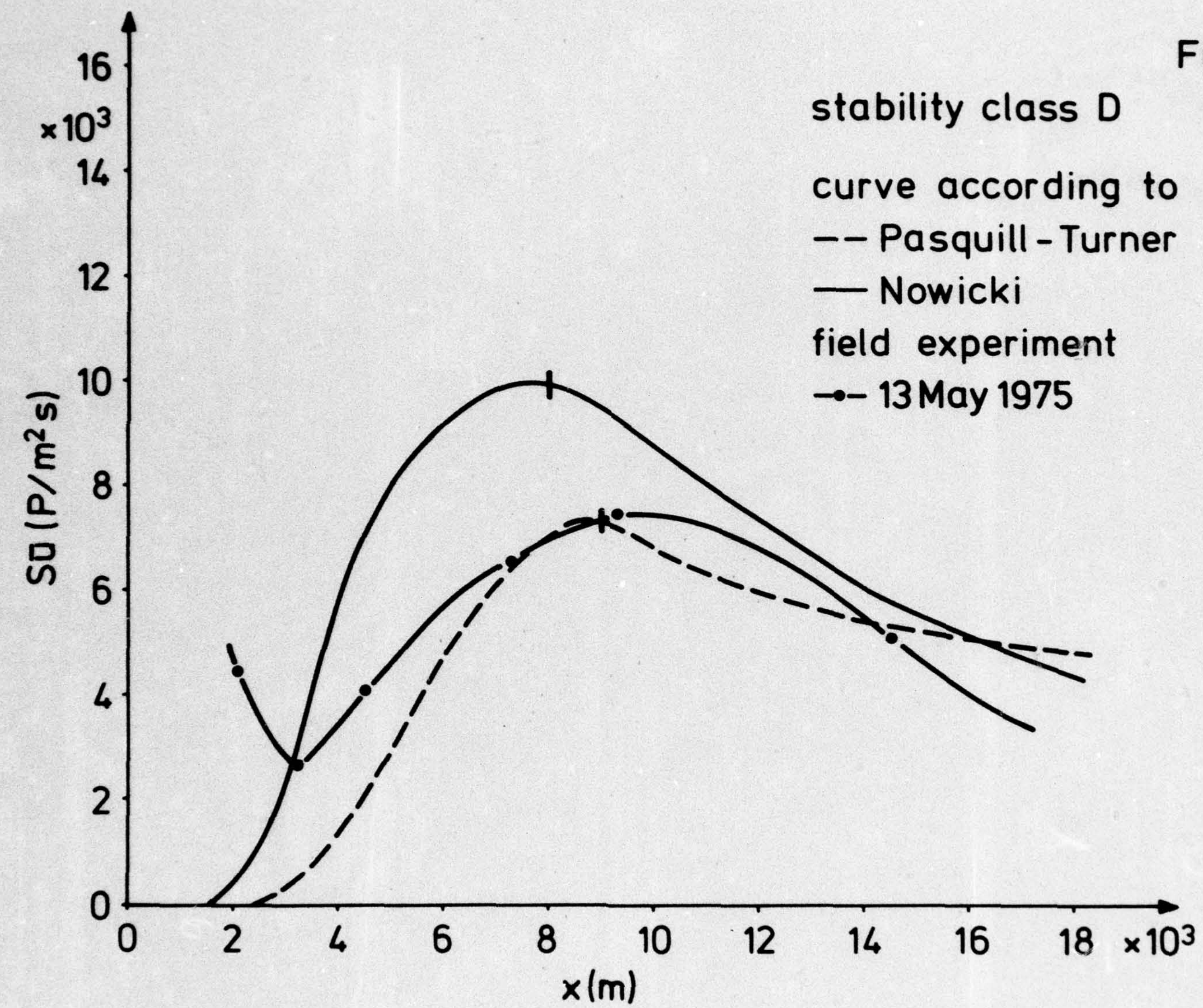
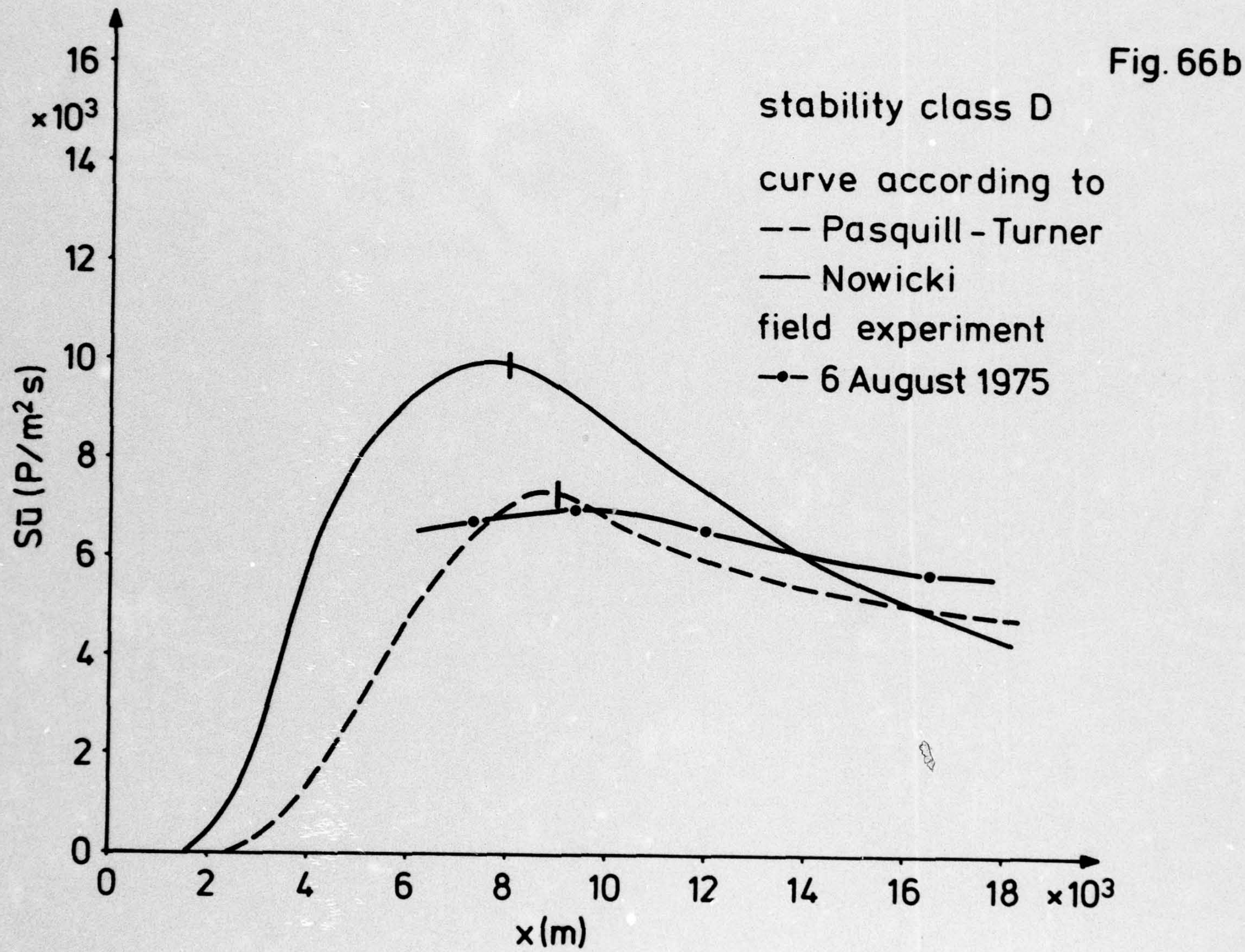

stability class C
curve according to
Pasquill - Turner
Nowicki
field experiment
13 August 1975
16
×10³
14
12
10
8
6
4
2
0
Sū (P/m² s)
0
2
4
6
8
10
12
14
16
18
×10³
x (m)

Fig. 66a



stability class D
curve according to
-- Pasquill - Turner
— Nowicki
field experiment
-•- 13 May 1975
SD (P/m²s)
×10³
x (m)
×10³

Fig. 66b



stability class D
curve according to
-- Pasquill - Turner
— Nowicki
field experiment
-•- 6 August 1975
Sū (P/m²s)
×10³
16
14
12
10
8
6
4
2
0
2
4
6
8
10
12
14
16
18
×10³
x (m)

Fig. 67

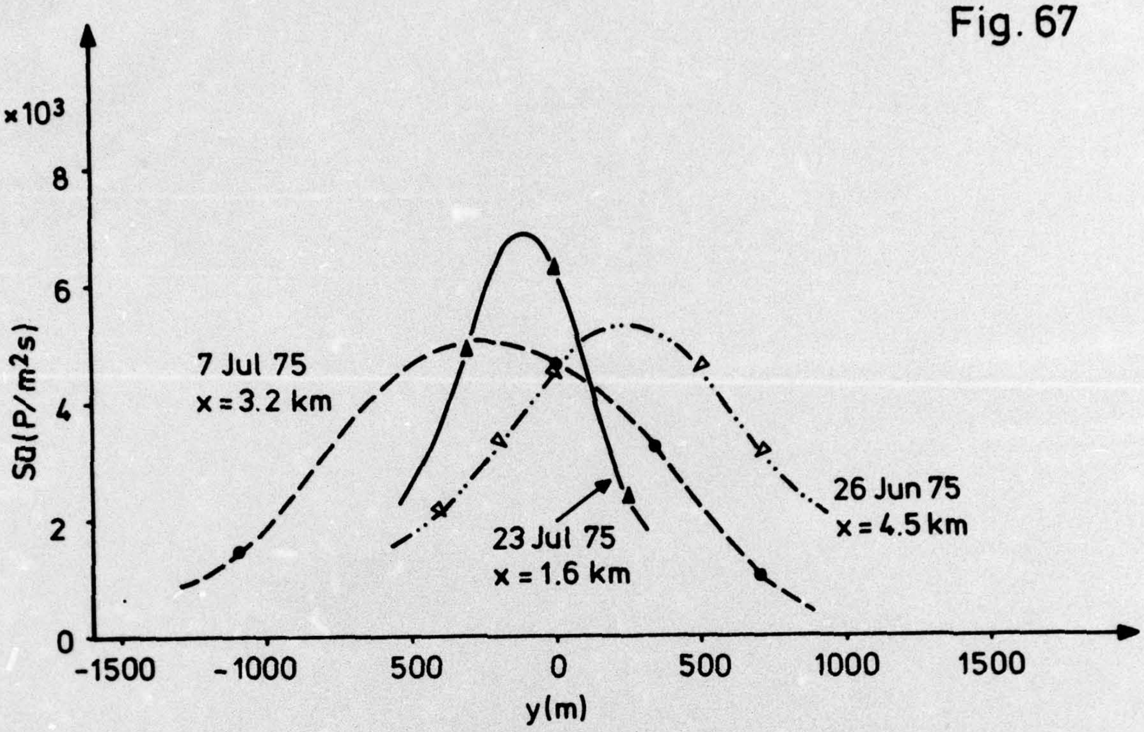

×10³
8
6
4
2
0
Sū(P/m²s)
7 Jul 75
x = 3.2 km
23 Jul 75
x = 1.6 km
26 Jun 75
x = 4.5 km
-1500
-1000
500
0
500
1000
1500
y(m)

Fig. 68

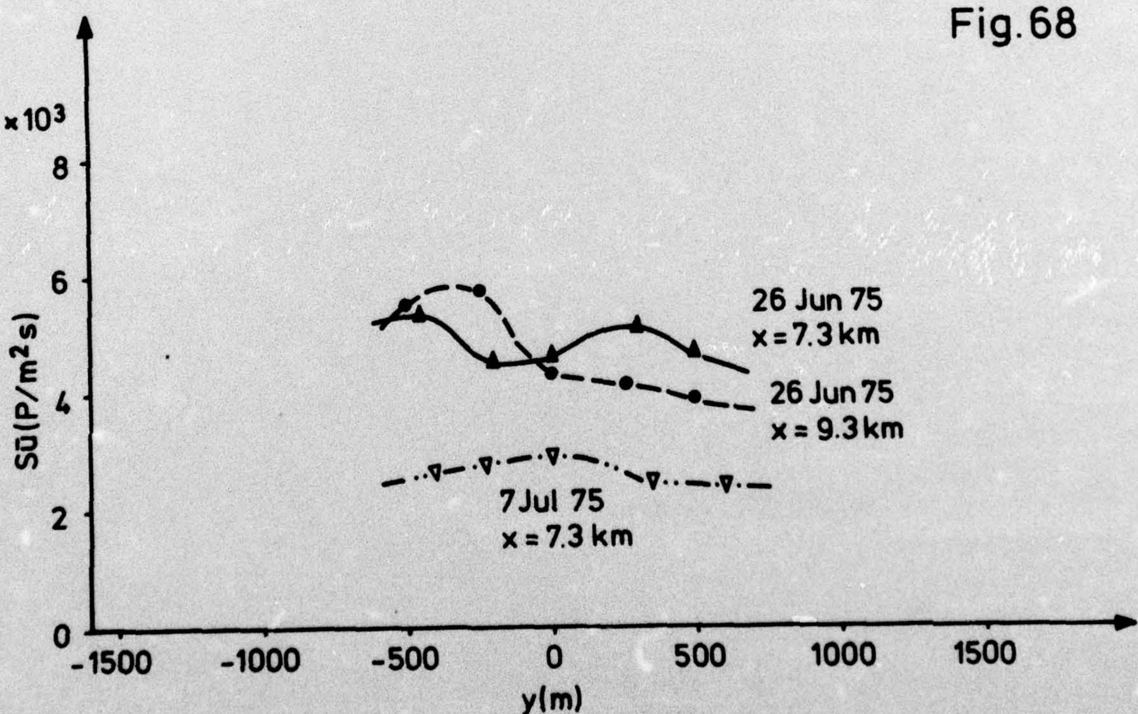
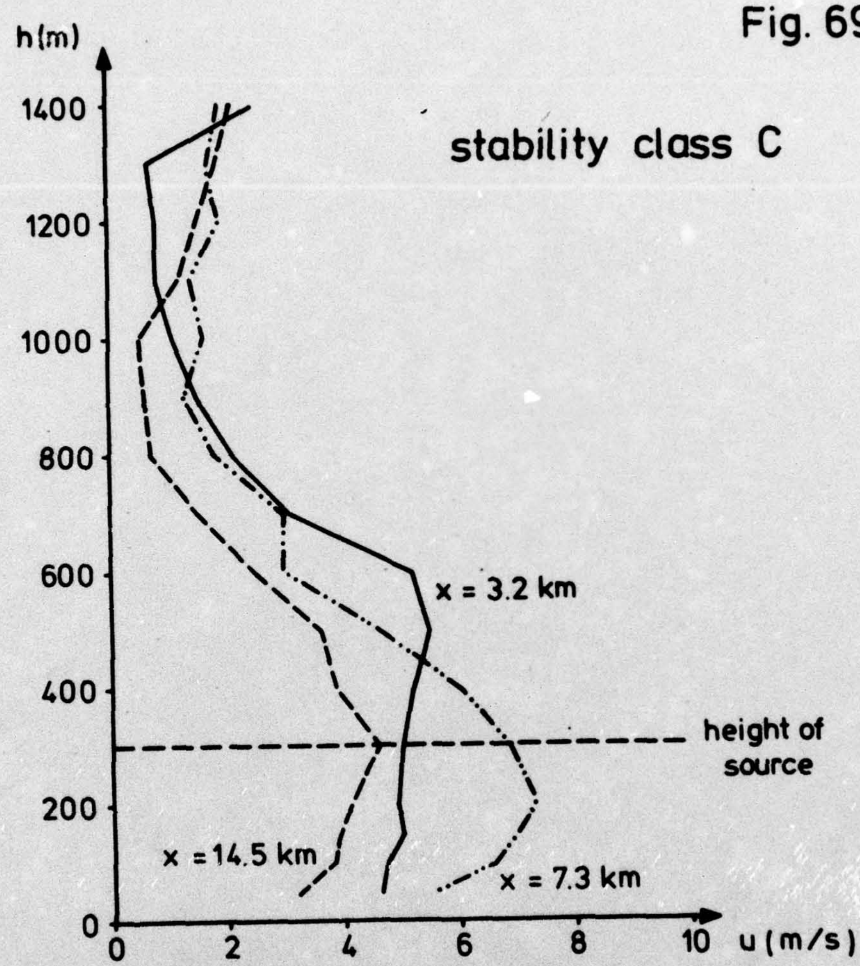

×10³
8
6
4
2
0
Sū(P/m²s)
26 Jun 75
x = 7.3 km
26 Jun 75
x = 9.3 km
7 Jul 75
x = 7.3 km
-1500
-1000
-500
0
500
1000
1500
y(m)

Fig. 69



h(m)
stability class C
1400
1200
1000
800
600
400
200
0
x = 3.2 km
height of source
x = 14.5 km
x = 7.3 km
0
2
4
6
8
10
u (m/s)